To Mr Edmund Wade
with Wm Lovell's best compliments
Augt 1871

ELEMENTARY

ANATOMY AND PHYSIOLOGY.

ELEMENTARY

ANATOMY AND PHYSIOLOGY,

FOR SCHOOLS AND PRIVATE INSTRUCTION;

WITH LESSONS ON DIET, INTOXICATING DRINKS, TOBACCO, AND DISEASE.

BY

WILLIAM LOVETT.

ILLUSTRATED WITH TEN COLOURED PLATES.

SECOND EDITION.

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MEDICAL OPINION

ON

THE IMPORTANCE OF TEACHING

PHYSIOLOGY AND THE LAWS OF HEALTH

IN COMMON SCHOOLS.

(*Extracted from the fourth Annual Report of William's Secular School, Edinburgh.*)

Our opinion having been requested as to the advantage of making the Elements of Human Physiology, or a general knowledge of the laws of health, a part of the education of youth, we the undersigned have no hesitation in giving it strongly in the affirmative. We are satisfied that much of the sickness from which the working classes at present suffer, might be avoided; and we know that the best-directed efforts to benefit them by medical treatment are often greatly impeded, and sometimes entirely frustrated, by their ignorance and their neglect of the conditions upon which health necessarily depends. We are therefore of opinion, that it would greatly tend to prevent sickness and to promote soundness of body and mind were the Elements of Physiology, in its application to the preservation of health, made a part of general education; and we are convinced that such instruction may be rendered most interesting to the young, and may be communicated to them with the utmost facility and propriety in the ordinary schools, by properly instructed schoolmasters.

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London: March, 1853.

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PREFACE.

This little work may be said to have had its origin in the efforts I have been making, for some time past, to impart to children some knowledge of their own physical, mental, and moral nature; believing it to be an essential and important branch of youthful education. In the pursuit of my object I have had to glean my information from many sources, and to simplify and condense it, and to give it in such a form as I thought might be best comprehended and appreciated by those I sought to instruct. And, having to some little extent succeeded, I have thought it might aid others, engaged in the great work of education, if I printed what I have taught in a lesson form; accompanied by drawings of the diagrams I used, together with an outline of the method I adopted, and still pursue, in teaching this kind of knowledge to several classes of both sexes weekly. It may probably be considered somewhat presumptious for me to put forth a work of this description, seeing that I have not received a professional education to qualify me for the task; and the more so as several useful works are already before the public on the subjects treated of. But, should such objections be raised, I have only to state that I have met

with many difficulties in my progress, for the want of condensed information in a lesson form, that I have laboured with some industry to glean and combine what knowledge I possess on the subject, and have laboured with equal zeal to impart it; and in publishing this little work my chief hope is to save others time and trouble in acquiring, and to give them some aid in diffusing a kind of information which I wish to see more generally, possessed by the people. The different works I have consulted, and to which I am chiefly indebted for the facts and information embodied in these lessons, are those of Jones and Richard Quain, Erasmus Wilson, John F. South, John Elliotson, Southwood Smith, Andrew and George Combe, William B. Carpenter, J. A. Paris, Robert D. Thompson, and M. Magendies' Lectures in the *Lancet*. It will be seen that in the body of the lessons I have avoided, as much as possible, abstruse technical terms, and where scientific names are required, as explanatory of the illustrations, &c., I have selected the most popular ones I could meet with, or those which I considered the least difficult for children to remember. Though I deem it necessary to state that I have found little difficulty in causing children, from nine to twelve years of age, to remember some of the most difficult names (such as those of the bones and muscles) after I had taken pains to give them clear ideas of the locality, part, organ, or function which the name represented. While, however, I have sought to embody in these lessons such information as I conceived requisite to convey a general idea of the different organs and

functions of the body, I have deemed it unnecessary to introduce any more than the most important of the muscles; a knowledge of the deep-seated ones being important only to those of the profession. The illustrations, suited to the lessons, have been drawn, lithographed, and coloured with some care, in order that teachers might be enabled to prepare others from them on a large scale. Those which I have found to be a good size, and which I have taught from myself, are about a yard and a half long, by two feet nine inches wide. I have them mounted on stout calico, varnished, and bound round with black tape. They are hung up and kept extended by means of two slips of hard wood, of an inch and a half wide, inserted into three loops of tape sewed to each end of the diagram. This plan I have found better than any permanent frame-work or roller, as two slips of wood will do for the whole set, and when taken out the diagrams can be rolled up in a small compass, and be better preserved from dust and injury. Persons having such diagrams made would be saved the trouble and inconvenience of mounting them, as well as find it the more economical, were they to procure the diagram paper already mounted and prepared for drawing on. This they can obtain, in London, of Mr. Charlton, at the Geological Society's Rooms, Somerset House, of whom I have purchased the paper for my own diagrams. It is mounted in lengths of about twelve yards long, and a yard and a half wide, and any number of yards can be obtained at two shillings a yard running measure. It might also be useful information to

those unacquainted with varnishing on paper, to inform them that the diagrams should have two coats of parchment size, carefully laid on with a soft brush, previously to the giving them one coat of good mastic varnish; otherwise they will appear black and spotted. Having said thus much of the diagrams required, I may now say a few words on the method of teaching which I have adopted in this particular; not that I think it anyways original, or superior to that of others, but with the desire only of aiding those who, like myself when I began, may have doubts and misgivings of their own powers. My classes vary in number from ten to thirty, the children's ages ranging from nine to fourteen. I have them generally arranged in a semi-circle before me, the diagram placed opposite to them on my right hand. I generally begin by giving them a short explanatory or dictation lesson, similar to those in the *Elementary Series*, questioning them generally and individually as I proceed; and, if they cannot sufficiently understand the subject in one lesson, I resume the explanation and questioning in one or more subsequent ones. When in this manner they are led to understand what is meant by Anatomy and Physiology—to know the different divisions of those sciences—the difference between organic and animal life—and to possess some knowledge of the nature of bone, cartilage, ligament, &c., I then proceed to teach them the names of the different bones that compose the skeleton. I have found it the best method to teach them the bones of one division before I proceeded to another; taking in order the head, trunk, and

extremities. To give a variety also to the lesson, I would suggest that the teacher, in questioning them, point at times to the different parts of his own body, instead of always directing their attention to the figure of the skeleton. In like manner he should seek to convey a knowledge of the muscles; causing them to understand the muscles that flex and extend different parts, pointing to the movements of his own limbs as he proceeds. After his first and necessary explanations, his great aim should be, by questioning and examining, to develope the children's own thoughts on the subject before them; taking care to appeal to them individually, otherwise the answers will be engrossed by a few of the most intelligent. And, if he seeks to make them clearly understand the locality and structure of the different organs as he proceeds, he will find it less difficult to make them understand the functions of such organs. In teaching the function of any organ, or set of organs, it will be well for him to commence with the first process, and then by his questioning to trace, step by step, one process after another on to its completion. As for instance, in the function of digestion he should begin with the first process, that of mastication; showing how it is effected, how the food is moistened, dissolved, elaborated, and absorbed, tracing its gradual progress onwards till the chyle is finally emptied into the venous blood. In my teaching hitherto I have had no reading lessons, but merely such explanatory and dictation lessons as I have described. But conceiving that an extension of the subject might be advantageous to the

teacher who may not have made those two sciences his study, as well as afford an additional means of impressing the previous lessons on the memories of the children, I thought it advisable to add the *Advanced Series* as reading lessons, for those who may like to adopt them. And in the foot-notes to this series I have also given a list of a greater number of muscles, with their technical names at length, for the benefit of those students who may wish to make themselves further acquainted with that branch of anatomy. In both series many repetitions may seem to be uncalled-for, but I have thought it well to make them for the pupil's sake.

The experienced teacher need not to be reminded that it will be well at all times to prepare his lessons; as this will give him power of condensation, and facility of explanation, not attainable by his mere dependence on the text-book, or by his relying on the thoughts of the moment.

Hoping that the desire to be useful may plead an excuse for the freedom of these observations, and that the ardent desire to see these two sciences more generally taught in our public and private schools will be some apology for the imperfections of the work, I most respectfully submit it to the public.

16, South Row, New Road.

INTRODUCTION.

What am I physically, mentally, and morally? What are the influences operating upon me for evil or for good? What power do I possess within myself to improve my own nature? How can I lessen the dominion of evil and extend the empire of goodness? These are questions *for individual solution*, on which must chiefly depend the freedom, prosperity, and happiness of our race.

To know our own nature is doubtlessly the first step in these enquiries; and the twin sciences, Anatomy and Physiology, present to us the key with which we may obtain access *to the world of wonders within ourselves.*——

Wonders, far surpassing in ingenuity, minuteness, power, and beauty, all that art has wrought, or mechanism achieved; such as are calculated to arouse our attention to the numerous ills that, now unheeded, impair their excellence, mar their functions, and too often cut short their existence.——

Wonders, unfolding to us those mental capabilities by the wise and skilful operation of which man is enabled to make all nature's powers and earth's productions minister to human happiness; such as should cause us to spurn all

sordid, grovelling, and sensual vice, and awaken us to a sense of our mental dignity.——

Wonders, to be discovered in the temple of our moral nature, the seat of the ennobling virtues in the extended brotherhood of man; qualities which should quicken the spirit of love and charity within us, and call forth noble resolutions and self-sacrificing actions to help onwards the enlightenment, improvement, and happiness of our race.

If it be asked, what is man's physical nature? *Anatomy* points to the beautiful outlines and fair proportions of his own structure; and directs his attention to the numerous parts and varied forms harmoniously combined to render that structure firm, flexible, and graceful.

It shows with what exquisite skill each joint is fitted for support or motion; how each bone combines the lightest material with the greatest strength; and how the whole are united to perform separate or combined movements upon principles of the highest mechanical accuracy.

It directs his attention inwardly to the careful arrangements which are there made for protecting his most important organs; so admirably contrived, that the soft brain shall expand the bony covering which shields it—that the lungs shall be guarded by the mechanism which moves them—and that the heart's untiring motion shall be secured amid all the varied movements of the body.

It also unfolds to him the numerous ligaments, cords, and tendons, by which his curious structure is braced firmly together and fitted for motion; shows him the multitudinous

tubes for supplying the whole with nourishment, and the myriad nerves by which the whole is stimulated, governed, and directed by the master organ.

Whilst *Anatomy* thus displays to him the beauty and variety of his physical structure, *Physiology* shows him the whole in active motion; reveals to him a thousand wonders connected with his yet unfathomable nature, and points out the laws and conditions he must observe if he would secure length of days and healthful existence.

On the threshold of his enquiries, his admiration and wonder will be excited as each link in the chain of being is passed in review before him, and he is made to perceive how necessary the existence of each is to the order and happiness of the whole.

Physiology represents to him a series of vital organisms, from the most simple to the most complicated, by which stones, earth, air, and water, are gradually converted into vegetable forms, clothing earth's nakedness with scenes of beauty, and providing subsistence for the varied tribes which dwell upon its surface; whose continuous existence, from the zoophyte to man, is dependant on that vital chemistry which converts the dead matter into a living thing.

His own digestive functions are in themselves a curious volume of chemical phenomena; in which is traced the complicated process by which every description of food is dissolved, changed, and elaborated, so as to form the living fluid on which existence depends.

And when he observes the admirable mechanism for

unceasingly propelling this same fluid through every minute tissue of his body, depositing in its course the different elements necessary for the growth and nutriment of every part, and knows that all those parts are constantly changing their particles, yet ever preserving their peculiar forms and features; he cannot fail to perceive powers and agencies far surpassing all that the science of chemistry can effect.

What too can more command his admiration than the ingenious contrivance of his own lungs? which in one moment breathe forth a poison that would otherwise contaminate or destroy, and in the next inhale a life supporting air, to free the blood from its impurities, and send it back to the heart, bright, florid, and invigorating.

Indeed every part, and every silent function of the human system, is a subject fraught with interest to every reflecting person.

Whether he regards the extreme minuteness of the muscular fibre or bony particle, whether he considers the minuteness of the myriad vessels which supply them with nourishment, or the more delicate vessels which in turn convey blood to nourish them, or the still more minute nerves which surround and stimulate the whole to action, they are alike objects of interest worthy of his study and research.

The force, life, and unceasing activity, displayed by all the bodily functions are no less surprisingly wonderful. One set of vessels are found to be constantly absorbing, purifying, and elaborating, new vital elements to supply the

wearing tissues ; another set are actively engaged in collecting the waste and disintegrated particles, so that nothing may be lost, and preparing them for again mixing with the stream of life ; others again are actively separating and distilling their peculiar fluids, some to supply the wants of the system, and others to free it from waste and impurities ; and all this activity and busy life within us constantly going on, day and night, from the morn of life till the eve of death, are subjects calculated to arouse the curiosity of the most sluggish and apathetic mind.

But curious and complicated as is man's *physical* structure, and wonderful as are its diversified functions, they all shrink into littleness and insignificance when contrasted with his *mental* and *moral* powers and capabilities ;—those great distinguishing attributes of his nature, to which he owes his present elevation, and on which his happier destiny must depend.

These powers, when expanded by education and enriched by knowledge, prove his superiority over all the rest of the animal creation ; but, when all these are neglected ; when he is cut off or deprived of all useful instruction, and left to the mere animal instincts and impulses of his nature, he is found to be far more helpless than many of the inferior animals.

In such an uncultivated and degraded state many of them outstrip him in cunning, strength, and dexterity—in providing a comfortable habitation, to secure warmth and shelter for himself and his offspring, the tiny bird may be

said to be his master and instructor—in prudentially storing up the plenty of summer for the wants of winter, the ant, the squirrel, and the bee are greatly his superiors—and in the arts of building, spinning, weaving, and plastering, the beaver, silkworm, spider, bee, bird, and insect, are many of them centuries in advance of his first rude and barbarous efforts.

But nature, having endowed him with high mental and moral powers, giving him keener perceptions and superior reasoning faculties, and having likewise bestowed on him the gift of communicating his ideas to his fellows, has enabled him gradually to disseminate his discoveries—to construct language—to record his experience—and to make the knowledge and wisdom of the past contribute to the wants of the present.

By these powers he may be said to have conquered all the kingdoms of nature, and have still unexhausted fields before him for future conquests.

His million-peopled cities, daily supplied and peacefully and orderly conducted, proclaim his progress and attest his triumphs, over the forest hut, the precarious subsistence, and hourly dangers of a savage life.

His labour-saving mechanism, his wondrous productive powers, his achievements in manufactures, his skill in art, his patient plodding industry, unwearied application and prudent foresight, prove how successfully he has mastered the careless indolence, the momentary impulse, and dark ignorance of primitive barbarism.

His glorious means of communication at home and abroad—his merchantmen, railways, telegraphs, and steamships—his science to construct and wisdom to guide them—have enabled him to convert barren rocks into homes of plenty, teeming with the productions of every clime—have given him power to greatly equalize the disproportions of nature, and cause realms of abundance to bless with their superfluities lands less fruitful, desolate and famine stricken. And thus by enabling nations to interchange ideas and commodities, he has stimulated knowledge, industry and art in all regions of the globe.

But while these achievements mark the progress of his race, much evil still exists to prove the wide extent of his ignorance and imperfections; and to show him the mental and moral heights he has yet to climb before he will be worthy of the title of a civilized being.

The *physical diseases* engendered by his crowded and ill-ventilated habitations—by the putrid and decaying substances he permits around him—by his filthy alleys and badly drained streets—by his scanty or improper food—by impure water "and mind debasing drink;"—all these evils, and the great mortality they occasion, prove how ignorant and neglectful he still is of the laws conducive to his own health, and that of his brethren.

The *moral evils*, exhibited in his wars abroad and oppressions and injustice at home—in his class denominations and sectarian intolerance—in his constantly increasing prisons, bridewells, penitentiaries, and work-houses—prove him to

be *still defectively taught, badly trained, and morally deficient,* in all the requisites necessary for forming a human being best able to enjoy his own existence, best qualified to be useful in society, and best disposed to increase and extend the means of happiness among all the nations of the earth.

To aid in the removal of these evils—these individual, social, and national wrongs—and to the reforming, teaching, and training men to act wisely, justly, and usefully, is evidently our highest duty, as it shall be our highest reward.

HUMAN ANATOMY, PHYSIOLOGY, &c.

ELEMENTARY SERIES OF LESSONS.

LESSON I.

PHYSIOLOGY, &c.

All living beings have a peculiarity of form and *structure*, and are provided with different *organs*[1] for promoting their growth and nourishment.

The science of ANATOMY makes us acquainted with the form, structure, position, and connection of those different parts and organs which belong to the being *irrespective of life.*

The science of PHYSIOLOGY is that which makes us acquainted with the functions, or actions, of all those organs; and of all those general laws necessary *for preserving the life of the being.*

Physiology is divided into three great branches—the first, describing the functions of the vegetable world, is called *Vegetable Physiology;* the second, treating of the whole animal kingdom, is called *Animal or Comparative Physiology;* and the third, which treats of human beings in particular, is called *Human Physiology.* The science of Anatomy admits also of different divisions.

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[1] An *organ* is an arrangement of parts for performing a particular action or function—thus the stomach is an organ for performing the function of digestion.

The great distinction between the vegetable and animal world is, that the latter possesses *two* distinct kinds of lives, and the former, as far as we can judge, but only *one*.

The beings of the vegetable world are provided with *organs* for sustaining themselves on a particular spot of earth or water; they possess what is called an *organic life*.

Those of the animal world have also an organic life, but in addition to that they have, from the lowest to the highest forms, some power of choice and motion; this is called their *animal life*.

In human beings the functions of their *organic life* are those of digestion, circulation, respiration, secretion, &c.—of their *animal life*, those of sensation, thought, will, motion, &c.

The human body is made up of a great variety of parts, and these parts of upwards of twenty different substances; such as bone, muscle, tendon, cartilage, ligament, membrane, nerve, fat, &c., the whole of which have been built up and are constantly nourished by one life-sustaining fluid *the blood*.

QUESTIONS.

What is Physiology?
How is it distinguished from Anatomy?
How many great branches is Physiology divided into?
Name those branches.
What distinguishes the vegetable from the animal kingdom?
What is meant by an *organic life?*
What by an *animal life?*
Name some of the functions of the two lives in human beings?
What is meant by an organ in animal life?
What is meant by a function?
How many different substances is the body formed of?
Name some of those substances?
What is it that forms and nourishes those different substances?

LESSON II.

THE BONES.

The hard bony frame-work of the human body is called the *skeleton.*

This structure is admirably formed for voluntary[1] motion, as well as for protecting the most important organs within the body.

It is divided by anatomists into three principal divisions, called the *head,* the *trunk,* and the *extremities;* each division being composed of a great number of bones articulated together, and firmly united by means of sutures,[2] cartilage,[3] or strong ligaments.[4]

The extremities are joined to the trunk by what are called ball and socket joints,[5] but most of the other movable joints are termed hinge[6] joints.

Bones are of various and peculiar forms combining lightness with great strength. They derive their nutriment from the blood, and are therefore provided with arteries veins, and nerves, though these are few in number compared with many other parts of the body.

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[1] *Voluntary,* dependant on the will.

[2] *Sutures,* seam-like joinings, as in the skull.

[3] *Cartilage,* a gristly substance covering the end of bones, but sometimes placed between them, as in the bones of the spine.

[4] *Ligaments,* white fibrous bands for binding parts together.

[5] *Ball and socket joints,* like a cup and ball, giving great freedom of motion, as at the shoulders and thighs.

[6] *Hinge joints,* as at the elbows and knees.

Bones are composed for the most part of an animal substance called gelatine,[7] and of an earthly substance called phosphate[8] of lime; to the one belongs life and nourishment, and to the other hardness. The gelatine forms the larger proportion in youth, and the lime in old age.

Broken bones are reunited by the parts being placed opposite to each other and kept fimly in their place; the vessels secreting bony material to effect the junction.

QUESTIONS.

What is the skeleton?
What seems to be the object of its structure?
What is meant by voluntary motion?
Name the principal divisions of the skeleton,
What is meant by bones being articulated together?
What are sutures, cartilage, and ligaments?
Name the kind of joints at the shoulders and knees.
What are the forms of bones said to be?
What do they combine?
How are bones nourished?
What are they chiefly composed of?
What is gelatine?
What is phosphate of lime?
Which of those two substances is connected with the growth of bones?
What is the use of the other substance?
Why should bones readily bend in childhood and break in old age?
What should this teach us respecting children?
What respecting our care of the aged?
How are bones united again when broken?

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[7] *Gelatine*, a glue-like substance.
[8] *Phosphate of lime*, phosphoric acid and lime chemically combined.


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DESCRIPTION OF THE BONES.

PLATE 1.

The three great divisions of the Skeleton being the Head, Trunk, and Extremities.

THE BONES OF THE HEAD.

1. The Frontal bone.
2. The two Temporal bones.
3. The two Parietal bones.
4. The Occipital bone.
5. The Ethmoid and Sphenoid bones at the base of the skull.
6. The two Nose, or Nasal bones.
7. The Vomer, which separates the nostrils.
8. The two Turbinated bones of the nose.
9. The two Lachrymal bones in the orbits of the eyes.
10. The two Cheek, or Malar bones.
11. The two Upper Jaw, or superior Maxillary bones.
12. The Lower Jaw, or inferior Maxillary bone.
13. The two Palatine bones of the Mouth.
14. The thirty-two Teeth, sixteen in each Jaw.

THE BONES OF THE TRUNK.

15. The seven Neck, or Cervical Vertebræ
16. The twelve Back, or Dorsal ditto.
17. The five Loin, or Lumbar ditto.
18. The Breast bone, or Sternum.
19. The seven true and five false Ribs, or Costae.
20. The Pelvis, which is formed of the Sacrum, or base of the Spine, the two Innominata, or Hip bones, and the Coccyx.

THE BONES OF THE EXTREMITIES.

21. The two Shoulder bones, or Scapulæ.
22. The two Collar bones, or Clavicles.
23. The upper Arm bone, or Humerus.
24. The two bones of the Fore-arm, or the Radius (*a*) and Ulna (*b*).
25. The eight Wrist, or Carpal bones.
26. The five Hand, or Metacarpal bones.
27. The fourteen Finger bones, or Phalanges of the Hand.
28. The four Sesamoid bones of the hand.
29. The Thigh bone, or Femur.
30. The Knee bone, or Patella.
31. The two Leg bones, or the Tibia (*c*) and Fibula (*d*).
32. The seven Instep, or Tarsal bones.
33. The five Foot, or Metatarsal bones.
34. The fourteen Toe bones, or Phalanges of the Foot.
35. The four Sesamoid bones of the Foot.

ON THE SCROLL.

a. The Occipital bone, showing the large opening for the nerves.
b. The Axis and Atlas, being the two top cervical bones.
c. The Hyoides or bone of the tongue.
d. The Clavicle, or collar bone.
e. The Scapulæ, or shoulder bone.
f. The Sacrum, and Coccyx.

The Heel bone, being a part of one of the Instep bones, is called the Os Calcis.

LESSON III.

THE MUSCLES.

The muscles of the body in our ordinary language are called flesh. They are those fleshy, fibrous[1] cords and layers which are attached to the bones, for the purpose of moving them in different directions; and are of different forms according to the bones they are required to move.

They are generally arranged in pairs, and almost every muscle has its antagonist, or opposing muscle.

Muscles are mostly thick and fleshy in the middle, and they gradually become thinner and tendinous[2] towards the ends; the parts by which they are attached to the bones.

They are made up of a great number of little fibrous bundles of flesh, each bundle being enclosed in a sheath membrane,[3] so that they may all move freely one over the other; and every fibrous thread is supplied with blood vessels and nerves.[4]

The muscles move the bones by being contracted or shortened by the influence of the nerves. That is when the brain desires any limb to be moved it makes known its will to the nerves, the nerves immediately cause every fibre of the muscle to contract or shrink from both ends towards

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[1] *Fibrous*, made up of small *threads* of flesh or other substances.

[2] *Tendinous*, composed of whitish fibrous cords, such as are seen in a cow-heel.

[3] *Membrane*, a thin delicate layer.

[4] *Nerves*, small white cords, being the medium of communication with the brain.

the centre of the muscle, which being thus shortened causes the limb to move.

Such of the muscles as are under the controul of the will are called *voluntary*[5] muscles; but those which move without consulting us, as the heart, stomach, and other organs, are called *involuntary* muscles.

If muscles are not *properly exercised* they will become small in bulk and weakened in power, exercise being necessary to force the blood through the different vessels so as to nourish and expand each fibre of which they are composed.

QUESTIONS.

What are muscles?
Explain the use of muscles.
How are they arranged?
What is meant by an antagonist muscle?
What is the difference between the belly and the ends of a muscle?
What is tendon like?
What are the parts of a muscle called by which it is attached?
What are muscles made up of?
What is membrane?
How are muscles nourished?
What cause the muscles to contract?
What is meant by contraction?
Where do the nerves proceed from?
What is meant by voluntary and involuntary muscles?
Why is exercise good for the muscles?

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[5] *Voluntary*, moved by the power of the will.

DESCRIPTION OF THE CHIEF MUSCLES ON THE FRONT FIGURE.

PLATE 2.

1. The broad muscle of the Scull, or the Occipito Frontalis.
2. The three muscles for moving the Ear, or the Aural muscles.
3. The circular muscle of the Eye, or the Orbicularis Palpebrarum.
4. The muscle to raise the upper Eyelid, or the Levator Palpebræ.
5. The four muscles of the Nose, or the Nasal muscles.
6. The circular muscle of the Lips, or the Orbicularis Oris.
7. The muscles to raise the upper Lip, or the Levator Labii Superior.
8. The muscles to depress the lower Lip, or the Depressor Labii Inferior.
9. The muscles for drawing up the corners of the Mouth, or the Levator Anguli and Zygomatic muscles.
10. The muscles for drawing down the corners of the Mouth, or the Depressor Anguli Oris.
11. The muscles for lessening the cavity of the Mouth, or the Buccinator muscles.
12. The muscles for drawing up the lower Jaw, or the Masseter and Temporal muscles.
13. The muscles for drawing down the lower Jaw, or the Digastricus.
14. The muscles to turn and bend the Head, or the Mastoideus muscles.
15. The thin muscle of the Neck, or the Platysma Myoides muscle.
16. The muscles to draw the Shoulders forward, or the great Serratus muscles.
17. The muscle for raising the Arm at the Shoulder joint, or the Deltoid muscle.
18. The muscles for drawing the Arm towards the Chest, or the Great and Little Pectoral muscles.
19. The muscles for bending the Fore Arm, or the Biceps and Brachialis muscles.
20. The muscles for bending the Fingers, or the Deep and Superficial Flexors of the Fingers.
21. The muscles for turning the Palm of the Hand up and down, or the two Supinators and two Pronators.
22. The muscles for causing quick movements of the Fingers, or the Palmar muscles.
23. The muscles to draw up the Ribs in breathing, or the Intercostal muscles.
24. The muscles to draw down the Ribs and compress the Abdomen, or the Oblique and Straight Abdominal muscles.
25. *The muscles to bend the Thigh on the body, or the Psoas (*a*) and Iliac muscles (*b*).
26. The muscles to straighten the Leg, or the Rectus Femoris (*c*), the Rectus Cruris (*f*), the Vastus Externus (*d*), and Vastus Internus muscles (*e*).
27. The muscles for crossing the Legs, or the Sartorius muscles.
28. The muscles for bending the Foot, and extending the Toes, or the Front Tibial, the Peroneal, and Long and Short Extensor muscles of the Toes.
29. The muscles for causing quick movements of the Toes, or the Dorsal and Plantar muscles.
30. The annular, or ring-like ligament of the Foot.

The superficial muscles are supposed to be removed from the left side of the figure, in order to show those beneath them.

* *a* On the side diagram is intended to show the contraction of the muscular fibre.

E B Bacon del

George, Lithographer Hatton Garden


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DESCRIPTION OF THE CHIEF MUSCLES OF THE BACK FIGURE.

PLATE 3.

1. The broad muscle of the Skull, or the Occipito Frontalis.
2. The three muscles for moving the Ear, or the Aural muscles.
3. The muscles to turn and bend the Head, or the Mostoideus muscles.
4. The muscle to draw back the Head and raise the Shoulders, or the Trapezius muscle.
5. The muscle for raising the Arm, or the Deltoid muscle.
6. The muscles to draw down the Arm when raised, or the Latissimus Dorsi.
7. The muscles for straightening the Fore Arm, or the Triceps and Anconeous muscles.
8. The muscle for extending the Fingers, or the Common Extensor of the fingers.
9. The muscles for turning the Palm of the Hand up and down, or the two Supinators and two Pronators.
10. The annular ligament of the Wrist.
11. The muscles for causing quick movements of the Fingers, or the Palmar muscles.
12. The muscles for extending the Thigh, or the three Gluteal muscles.
13. The muscles for bending the Leg, or the Semidendinosus and the Semimembranosus (*a*) and Biceps Femoris (*b*).
14. The muscles for extending the Foot and bending the Toes, or the Gastrocnemii, the Soleus, the Plantaris, the Back Tibial, and Flexors of the Toes.
15. The tendon of Achilles.
16. The muscles for causing quick movement of the Toes, or the Dorsal and Plantar muscles.
17. The annular or ring-like ligament of the Foot.

THE SIDE DIAGRAM IS A MAGNIFIED VIEW OF THE SKIN.

a. The Scarf Skin, or the outer cuticle.
b. The Mucous Coating, or middle layer of the skin.
c. The True Skin, or Cutis.
d. Represents two hair bulbs, with Sebaceous glands leading to them.
e. The two Sudoriparous, or Sweat glands, with their spiral ducts.
f. Sebaceous glands of various sizes.

LESSON IV.

THE SKIN AND ITS FUNCTIONS.

The skin is that tough elastic membrane which covers our bodies. Its use is to keep the various muscles in their place, and to protect the vessels and nerves beneath it from cold and injury.

It is composed of three distinct layers, one over the other.

The outside layer, or *scarf skin*, is a semi-transparent membrane destitute of feeling, and when viewed through a microscope seems to be made up of minute scales, constructed so as to allow of substances passing in and out between them.

The middle layer is a *mucous coating*,[1] forming the colouring material of the skin, being of different colours in different races. It serves to protect the delicate vessels beneath and to keep the nerves soft and pliable.

The under layer, or *true skin*,[2] is a thick fibrous membrane abounding in blood-vessels, nerves, and glands,[3] the upper surface of it forming so complete a net-work of them that the finest needle cannot be inserted without wounding a nerve or blood-vessel.

In its functions the skin is an *organ of touch*, through the medium of its nervous papillæ, or the extreme ends of the nerves, which push up the outer covering so as to form little paps.

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[1] *Mucous coating*, a thick tenacious secretion.

[2] *True skin*, that layer of the skin which in different animals is converted into leather.

[3] *Glands*, organs for secreting some kind of fluid.

It is an organ of *secretion*,[4] as it secretes, or separates, the waste fluid from the blood, called perspiration or sweat.

It is also an *organ of excretion*,[5] that is, it passes off, by sensible and insensible perspiration, the waste fluid, and other noxious materials of the body.

It is likewise an *organ of absorption*,[6] that is, it readily draws in and passes into the circulation of the blood various substances brought in contact with it.

It has been estimated, that of all the food taken into the body, more than one-third passes out again through the pores of the skin; and this fact clearly shows to us the great necessity for keeping the pores unobstructed.

The innumerable vessels and nerves beneath the skin also show us the necessity for warm clothing to protect them against damp and cold.

QUESTIONS.

What is the skin, and what its use?
Name the different layers of the skin.
Give a description of the scarf skin.
What is the middle layer like?
What is the true skin like?
What part of the skin of animals is formed into leather?
What are the general functions of the skin?
What makes it an organ of touch?
What secretes the perspiration?
State what is meant by excretion.
What is the use of perspiring?
Can you state what is meant by sensible and insensible perspiration?
What is absorption?
What part of the skin is it that blunts absorption?
What is it necessary to keep the skin clean?
Why is warm clothing necessary?

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[4] *Secretion*, the action of separating.
[5] *Excretion*, the passing outwards.
[6] *Absorption*, the action of sucking in.

LESSON V.

THE INTERIOR OF THE BODY.

In describing the different organs in the interior of the body it will be well to take the head, neck, and trunk, in their order from above.

The *head* contains the brain, four of the organs of sense, and the organs for masticating our food.

The *neck* contains the larynx,[1] the trachea,[2] the pharynx,[3] the esophagus,[4] a portion of the spinal cord,[5] and branches of the veins,[6] arteries,[7] and nerves.

The *trunk* is divided into two compartments by means of a thin muscle called the diaphragm, extending midway across the body.

The upper compartment, called the thorax, or chest, contains the heart, or the chief organ of circulation; and the lungs, or the chief organs of respiration.

The lower compartment, called the abdomen, contains the liver, or the large gland which secretes the bile: the pancreas, or the gland which secretes the pancreatic juice: the stomach, or the chief organ of digestion: the duodenum, or the first twelve inches of the small intestines in which the

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[1] The *larynx*, or the organ of voice.
[2] The *trachea*, or the wind-pipe.
[3] The *pharynx*, or the opening into the food-pipe.
[4] The *esophagus*, or the food-pipe.
[5] The *spinal cord*, or the chief branch of the nerves.
[6] The *veins*, or tubes for conveying impure blood to the heart.
[7] The *arteries*, or tubes for conveying pure blood from the heart.

chyle is formed: and the small intestine in which the chyle is absorbed by the lacteals.

Also the large intestines, or the receptacle for containing the innutritious portion of the food.

The kidneys, or the two glands for secreting the water; the bladder, or the receptacle for containing it; and the two tubes which convey the water from the kidneys to the bladder.

Also the aorta, or the chief branch of the arteries, as well as the chief branch of the veins.

These different organs are for the most part protected and kept in their position by thin, tough membranes, to different parts of which different names are given.

QUESTIONS.

What are the organs contained in the head?
Do you know the use of the brain?
Can you name the organs of sense?
What are the organs for masticating our food?
Name the organs passing through the neck.
What are the larynx and trachea?
What are the pharynx and esophagus?
What is the spinal cord?
Describe the use of the veins and arteries.
Name the thin muscle that divides the trunk into two compartments.
What are the names given to those two compartments?
Name the organs contained in the thorax.
What is the use of the heart?
Do you know the use of the lungs?
Can you name the organs contained in the abdomen?
What is the liver, and what its use?
State what each of the organs named is for.
How are all those organs kept in their position?

DESCRIPTION OF THE INTERIOR OF THE BODY.

PLATE 4.

1. The upper portion of the Brain, or the Cerebrum.
2. The lower portion, or the Cerebellum.
3. The chief branch of the Nerves, or the Spiral Cord.
4. The chief organ of Speech and Taste, or the Tongue.
5. The soft and bony Palates.
6. The entrance to the Food-pipe, or the Pharynx.
7. The food-pipe leading to the Stomach, or the Esophagus.
8. The chief organ of the Voice, or the Larynx, being the top of the Trachea.
9. The wind-pipe for conveying air to the Lungs, or the Trachea.
10. The two branches of the Trachea, or the Bronchi.*
11. The chief organs of respiration, or the Lungs.
12. The chief organ of circulation, or the Heart.
13. The bag which encloses the Heart, or the Pericardium.
14. The muscle which separates the Thorax from the Abdomen.
15. The large gland which secretes the bile, or the Liver.
16. The chief organ of digestion, or the Stomach.
17. The gland called the Pancreas, situated behind the Stomach.
18. The gland called the Spleen, at the left end of the Stomach.
19. The first part of the Small Intestines in which the chyle is formed, or the Duodenum.
20. The Small Intestines, in which the chyle is absorbed by the Lacteals.
21. The Large Intestines, the receptacle of the innutritious portion of the food
22. The chief branch of the arteries, or the Aorta.*
23. The two glands for secreting the water, or the Kidneys.*
24. The receptacle for containing the water, or the Bladder.

* These organs whose position is marked by dotted lines are situated behind others.


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LESSON VI.

THE ORGANS OF DIGESTION.

The organs of digestion are the mouth, teeth, tongue, salivary glands, the pharynx, the esophagus, the stomach, the duodenum, the liver, the pancreas, the small and large intestines, the lacteals, the mesenteric glands, and the thoracic duct.

The *mouth* is the cavity formed by the cheeks, jaws, and palates. The *teeth* are thirty-two in number, sixteen in each jaw; they are distinguished as incisor,[1] canine,[2] and molar[3] teeth.

The *tongue* is made up of six muscles, well provided with blood vessels and nerves, and is supported at its base by a small bone of a horseshoe[4] form.

The *salivary glands*[5] are six in number, three on each side of the mouth.

The *pharnyx* is the large cavity on the top of the *esophagus*, down which the food passes into the stomach.

The *stomach* is a strong muscular bag, something in the form of a bagpipe, and capable of containing about three pints of food. It is situated in the upper part of the abdomen, chiefly on the left side. The large end on the

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[1] *Incisor*, teeth cutting like a scissors.

[2] *Canine*, teeth tearing like a dog.

[3] *Molar*, teeth grinding like a mill.

[4] The *hyoid bone*.

[5] The *salivary glands*, for secreting the saliva or spittle; called the parotid, the submaxillary, and the sublingual glands.

left side by which the food enters is called the cardiac end, and the other end, by which the food passes out, the pyloric end of the stomach. In the inner, or mucous coating, are the gastric vessels, that secrete the gastric[6] juice.

The *liver* is the large gland which secretes the bile ; it is situated in the upper part the abdomen, mostly on the right side; the bile is contained in a little bag called the gall bladder.

The *pancreas*, or sweet bread, is a gland situated behind the stomach; it is the organ which secretes the pancreatic juice.

The *duodenum* is the first twelve inches of the small intestines, joined to the small end of the stomach; it is the organ in which the chyle[7] is formed.

The *small intestines* are membraneous tubes, in which the nutritious portion of the food is absorbed by small vessels, having their mouths in the interior, called the *lacteals ;* the innutritious portion passing onwards to the receptacle called the *large intestines.*

The *mesenteric glands* are small glands between the folds of the mesentery ;[8] they serve to purify the chyle and pass it onwards into a small tube called the *thoracic duct*, by which it is carried upwards and emptied into the venous blood, at the junction of the subclavian and *left* jugular veins.

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[6] *Gastric juice*, the fluid secreted in the stomach for dissolving the food.

[7] The *chyle*, the nutritious portion of the food.

[8] The *mesentery*, the name of the membrane between the folds of which the intestines are supported.

QUESTIONS.

Can you name the different organs of digestion?
What forms the cavity called the mouth?
State the number of teeth we have.
Name the different kinds of teeth.
Can you describe the tongue?
How many salivary glands have we?
What is the pharynx?
Can you name the pipe down which the food passes?
Describe the form and size of the stomach.
State its situation in the body.
Name the two orifices of the stomach.
By which orifice does the food enter?
What is the gastric juice secreted by?
What is the first part of the small intestines called?
Name the organ that secretes the bile.
What is the organ called in which the bile is contained?
Where is the liver situated?
What is the pancreas, and where is it situated?
Can you describe the small intestines?
What are the lacteals?
Can you describe the mesenteric glands?
What is the thoracic duct?
Where is the chyle conveyed to by the thoracic duct?

DESCRIPTION OF THE ORGANS OF DIGESTION.

PLATE 5.

1. The organs of Mastication; or, the Incisor, Canine, and Molar teeth.
2. The glands which secrete the saliva; or, the Parotid, Submaxillary, and Sublingual glands.
3. The top of the tube into which the food is passed from the mouth; or the Pharynx.
4. The tube by which the food is conveyed to the stomach; or, the Esophagus.
5. The entrance into the stomach; or its Cardiac end.
6. The chief organ of Digestion, in which the food is dissolved into chyme; or, the Stomach.
7. The passage for the chyme to pass out of the Stomach; or, its Pyloric end.
8. The position of the Pyloric muscle that guards the passage.
9. The large gland which secretes the bile; or, the Liver.
10. The small bag for containing the bilious secretion; or, the Gall-bladder.
11. The gland (behind the Stomach) for secreting the Panceatic juice; or, the Pancreas.
12. The Spleen; the functions of which are not well understood.
13. The first twelve inches of the small intestines in which the chyle is formed; or, the Duodenum.
14. The organ in which the chyle is absorbed by the lacteals; or, the Small Intestines.
15. The receptacle for the innutritious part of the food; or, the Large Intestines.

THE SIDE DIAGRAM IS INTENDED TO SHOW THE DIFFERENT ORGANS BY WHICH THE ABSORBED CHYLE IS CONVEYED INTO THE VENOUS BLOOD.

a. The Spinal Column.
b. Portions of the Small Intestines, with the lacteals penetrating their coats.
c. The Lacteals conveying the chyle to the Mesenteric glands.
d. The Mesenteric glands emptying their contents into the Thoracic Duct.
e. The Thoracic Duct conveying the chyle upwards, and emptying it into the venous blood, at the junction of the Subclavian and Jugular veins.


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LESSON VII.

THE FUNCTION OF DIGESTION.

DIGESTION is the process by which food is converted into blood, or nutriment for our bodies.

The first process the morsel of food undergoes is that of *mastication*, or the cutting, tearing, and grinding it with the teeth, while at the same time it is moistened with the saliva.

Being thus masticated, and mixed with the saliva, it is gathered up by the tongue and cheeks and passed backwards into the pharynx, the muscles of which force it down the esophagus into the stomach,

As soon as the food has entered the stomach the blood vessels and nerves become excited, the gastric juice begins to flow, the vermicular[1] motion to commence, and the food to pass slowly round and round the stomach until the whole is dissolved into a soft pulp-like state called *chyme.*

As fast as every little portion of food is dissolved and carried towards the small end of the stomach, the *pylorus*,[2] relaxing allows it to pass out into the duodenum.

Into this last organ the bile[3] and pancreatic[4] juice flow,

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[1] *Vermicular*, a worm-like motion, produced by the contractions of the muscular coat of the stomach.

[2] *Pylorus*, the small muscle round the orifice, sometimes called the gatekeeper.

[3] *Bile*, a thick greenish fluid secreted by the liver.

[4] *Pancreatic juice*, a fluid in appearance like saliva. secreted by the pancreas.

which being gradually mixed with the digested food produce on it a peculiar change.

This change, which seems to be of a chemical nature, is the complete separation of the nutritious from the innutritious portion of the food, the nutritious being a milky white rich fluid called *chyle*.

The two substances being thus changed pass into the small intestines together, in the interior of which are the *lacteals*, minute vessels which gradually absorb[5] the chyle in its outward course; while the innutritious portion is gradually carried onwards to its receptacle, the large intestines.

The lacteals coursing their way through the coatings of the small intestines finally pass outwards, and having absorbed the chyle convey it onwards to the mesenteric glands.

The chyle in passing through two sets of these glands is enriched and purified, and becomes more and more of the nature of blood.

From the mesenteric glands it is conveyed into the thoracic duct, by which it is carried upwards and emptied into the venous[6] blood.

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[5] *Absorb*, to suck up.

[6] *Venous*, a dark impure kind of blood.

QUESTIONS.

What is digestion?
What is the first process the food undergoes?
What is meant by mastication?
Where is the masticated food first taken to?
What forces it down the esophagus?
When the food enters the stomach what takes place?
What is meant by the vermicular motion?
What is the partially digested food called?
By which end of the stomach does the chyme pass out?
Does it pass out gradually or otherwise?
Name the organ into which it enters.
What does the chyme meet with there?
What are these two fluids secreted by?
Describe the change effected by the bile and pancreatic juice.
What is the nutritious portion of the food called?
Where do these substances next pass to?
What are the vessels called that absorb the chyle?
Where do the lacteals convey it to?
What are the mesenteric glands for?
Say where the chyle is next taken to?
Where does the thoracic duct convey it to?

LESSON VIII.

THE ORGANS OF CIRCULATION.

The organs for circulating the blood through the body are the *heart*, *arteries*, and *veins*, the minute[1] branches of the two latter being called *arterial*, and *venous capillaries*.

The heart is a strong muscular bag of a conical[2] form, situated in the lower portion of the chest, its broad part about the centre, inclining backwards, and its point inclining a little to the left side.

Its interior is divided into four compartments,[3] the two upper ones called *auricles*, and the lower ones *ventricles*. It is also provided with ingeniously constructed valves,[4] to prevent the blood from flowing otherwise than in its right course.

The heart is kept in its right position, during the movements of the body, by means of the *pericardium*, a membraneous bag in which it is enclosed, as well as by the different vessels to which it is attached.

The vessels in which the pure blood is conveyed *from the heart* are called arteries, and those by which the impure blood is brought back *to the heart* are called veins.

The large branch of the arteries, proceeding from the heart, is called the *aorta*, and the two large branches of the veins, leading to the heart, the upper and lower *vena cavæ*.

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[1] *Minute*, small or slender.

[2] *Conical*, in the form of a cone.

[3] *Compartments*, chambers or divisions.

[4] *Valves*, membraneous constructions for admitting the blood to pass, and for preventing its return; the one on the right side called the *tricuspid*, and that on the left the *mitral valve*.

These large vesssls in their course through the body send out branches in different directions, and these again send out smaller and smaller branches like a tree, until at last they terminate in little hair-sized vessels called *capillaries*.

Most of the large branches of the arteries are protected from injury by being buried deep in the muscles; but at places where there is but little muscle their pulsations[5] may be felt, as at the wrist and temples. The coats of the arteries are stronger than those of the veins.

The veins are larger and more numerous than the arteries, and are provided with *valves* in their interior to prevent the retrograde[6] passage of the blood.

The large vessel for conveying the impure blood to the lungs is called the *pulmonary artery*, and the vessels for bringing back the blood from the lungs the *four pulmonary veins*.

QUESTIONS.

What is the organ called that forces the blood through the body?
What are the vessels called that convey the blood?
What is the heart like in form and structure?
Can you describe its position in the body?
How is its interior divided?
What are the upper compartments called?
Can you name the lower ones?
What are the valves of the heart for?
What keeps the heart in its right position?
Name the vessels that convey blood from the heart.
What is the chief branch of the arteries called?
Name the vessels that bring back the blood to the heart.
What are the large branches of the veins called?
Name the vessels that convey pure blood.
What are the extreme branches of blood vessels called?
Describe the difference between arteries and veins.
What occasions the pulsations at the wrists, &c.?

[5] *Pulsations*, the flow of the blood in jets as the heart contracts.

[6] *Retrograde*, the contrary, going back.

DESCRIPTION OF THE ORGANS OF CIRCULATION.

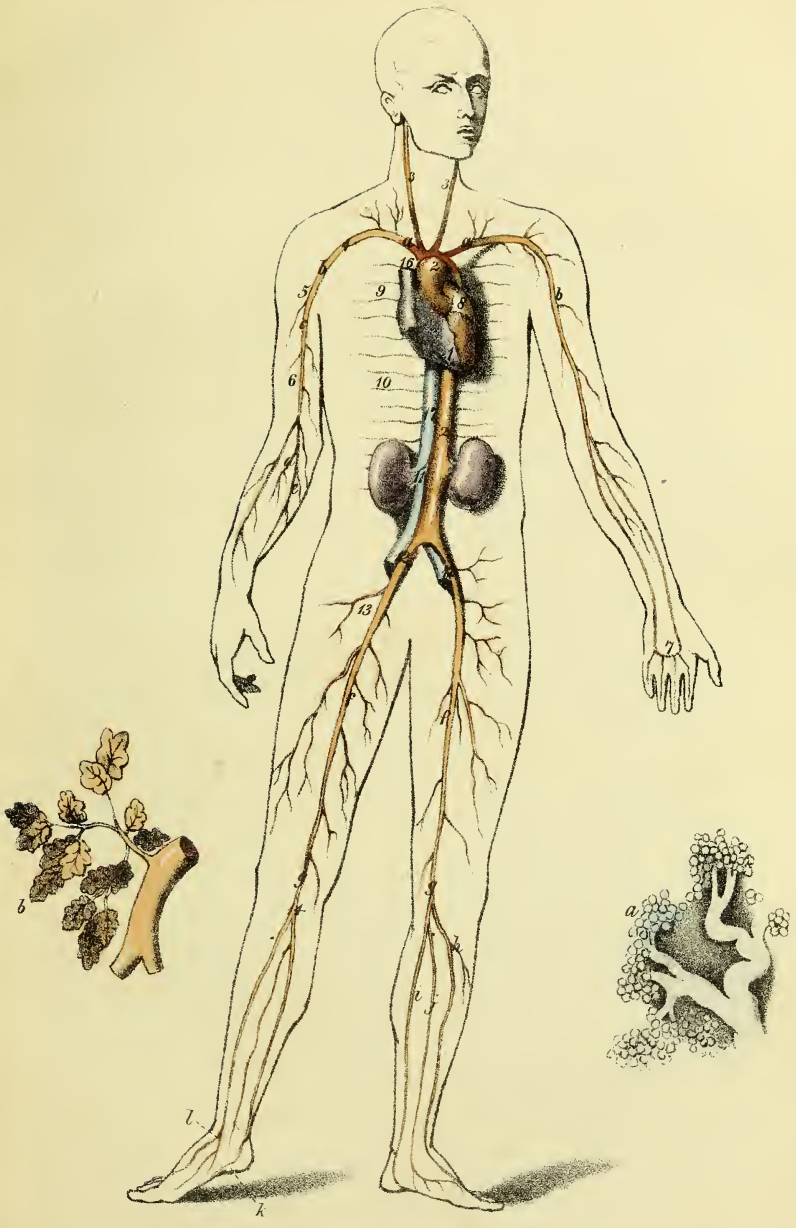
PLATE 6.

1. The chief organ of circulation; or, the Heart.
2. The chief branch of the arteries; or, the Aorta.
3. The branches of the Aorta for supplying the head and neck: or, the Carotid arteries.
4. The branches supplying the upper portion of the trunk, &c.; or, the Subclavian (*a*) and Axillary arteries (*b*).
5. The Axillary arteries in the arms become the Brachial arteries (*c*).
6. The Brachial divides and forms the Radial (*d*) and the Ulnar arteries (*e*).
7. The Palmar arch, sending off branches to supply the fingers.
8. The branches of the Aorta to supply the Heart itself; or, the Coronary arteries.
9. The branches to supply the muscles and organs of the chest; or, the Thoracic arteries.
10. The branches to supply the Diaphragm and organs of the abdomen; or, the Abdominal arteries.
11. The branches to supply the kidneys; or, the Renal arteries.
12. The Aorta dividing forms the Iliac arteries, supplying the lower portion of the trunk.
13. The Iliac entering the thighs become in their course the Femoral (*f*) and the Popliteal arteries (*g*).
14. The Popliteal in the legs divide into the Front and Back Tibial (*h*) (*i*), and the Peroneal arteries (*j*).
15. The branches of these in the foot form the Inner and Outer Plantar arteries (*k*) (*l*).
16. The trunk of the superior Vena Cavæ; or, the upper chief branch of the Veins.
17. The Inferior Vena Cavæ; or, the lower chief branch of the Veins.

THE SIDE DIAGRAMS.

a. Shows the structure of the Parotid gland, the secretory cells emptying their contents into the Salivary Duct.

b. Shows the structure of the Liver, and the manner in which its lobules are connected with the Hepatic vein.



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LESSON IX

THE BLOOD—ITS CIRCULATION.

The BLOOD is the material out of which the different parts of the body are formed, and by which they are nourished and sustained.

In the human body *arterial* blood is of a bright scarlet colour, and *venous* blood of a dark purple; in some animals however it is otherwise.

The blood, seen through a microscope, appears to be red flattish globules floating in a watery fluid. The quantity in an adult person is estimated to be from twenty-four to twenty-eight pounds.

The blood is circulated through the body by the alternate contractions of the *heart;* that is its different compartments squeeze or force the blood from one into the other in succession. They send out about two ounces at each contraction, amounting to many hogsheads daily.

When the venous, or impure blood is brought back to the heart it is emptied by two large vessels, called the *vena cavæ,* into the right auricle. The auricle immediately contracting upon the blood forces it down through a small valve,[1] into the right ventricle, which also contracting in its turn forces it out through the pulmonary artery into the lungs[2] to be purified.

When the blood is purified in the lungs it is conveyed

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[1] The *Tricuspid* valve.

[2] Described in the next lesson.

back again to the heart by four vessels, called the *pulmonary veins*, and by them is emptied into the left auricle. The left auricle immediately contracting forces the blood down through a small valve,[3] into the left venticle, which also contracting forces it up into the *aorta*, by which it is conveyed to the different arteries of the body.

The blood being thus distributed by the arteries into smaller and smaller branches, is conveyed at last by the *arterial capillaries*[4] to every minute part of the body. Here the blood begins its wondrous work of *nutrition;* that is it builds up, out of the same fluid, bone, muscle, fat, nerve, brain, and every other substance of the body.

By this process a portion of the nutritious elements[5] is extracted from the blood, and the waste and carbonacious matter combining with it causes it to become what is called *venous* or impure blood.

These small venous or impure streams in their way back to the heart first enter into the *venous capillaires* (which are continuous with the arterial capillaires), and these convey it into larger and larger branches till at last it is again emptied by the two vena cavæ into the right auricle of the heart; to be again circulated in the manner described.

The veins of the intestines, however, first pour their contents into a large trunk called the *vena portæ*, by which the venous blood is distributed throughout the liver to form the secretion[6] called *bile*, before it is emptied into the vena cavæ.

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[3] The *Mitral* valve.

[4] *Capillaries*, hair-sized vessels.

[5] *Elements*, the constituent parts.

[6] *Secretion*, separated and elaborated from the blood.

QUESTIONS.

What is the blood?
Describe some of its properties.
State the quantity of blood in the adult.
What forces the blood into circulation?
State the quantity sent out by each contraction.
What are the two large vessels called that bring the venous blood back to the heart?
Into which compartment of the heart is the venous blood emptied?
What takes place when the blood is in the right auricle?
Name the valve which it passes through.
Describe what takes place when it is in the right ventricle.
What is the vessel called that conveys it to the lungs?
When it is purified what vessels bring it back to the heart?
Into what compartment do the four pulmonary veins empty it?
What then takes place?
Name the valve the blood passes through.
When it is in the left ventricle what takes place?
Where is it conveyed to by the aorta?
What are the extreme ends of the arteries called?
What are they continuous with?
What is meant by nutrition?
How does the blood become venous?
State how the venous blood returns to the heart.
What is the vena portæ?
From what kind of blood is the bile secreted?

LESSON X.

ORGANS OF RESPIRATION.

The organs of respiration[1] are the trachea, the bronchi, the lungs, diaphragm, and muscles of the chest; together with the vessels for conveying the blood to and from the lungs.

The *trachea*,[2] or wind-pipe, is the tube by which the air is admitted from the mouth into the lungs; the top of it being called the larynx, or vocal organ. The trachea, on entering the chest, separates into two branches, called the *bronchi*, one going into each lung.

These branches separate into smaller and smaller branches, within the lungs, till at last they terminate in little globular cells; the small branches being called *bronchi*, or bronchial tubes, and the cells *air vesicles*.

The *lungs* are situated on each side of the chest, extending from about the first rib to the diaphragm. They are two light spongy bodies, chiefly made up of tubes, air vesicles, arteries, veins, nerves, and lymphatics;[3] the tubes and cells being lined with a thin mucous membrane, and the whole being enveloped, and attached to the sides of the chest, by a tough serous membrane called the pleura.

The blood is conveyed from the heart into the lungs by the two branches of the *pulmonary artery*; these separate

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[1] *Respiration*, the act of breathing.

[2] The trachea and bronchial tubes are always kept open to receive the air, by means of little rings of cartilage.

[3] *Lymphatics*, vessels to remove waste matter.

into smaller and smaller branches, throughout the lungs, till at last their capillaries[4] are spread out over the surface of the air vesicles.

The blood is conveyed back to the heart by means of the four *pulmonary veins*, the capillary branches of which are also spread out over the air vesicles in a similar manner to that of the arteries, and are continuous with them.

The thin muscle, called the *diaphragm*, which divides the thorax from the abdomen, and the intercostal[5] and straight abdominal muscles which move the ribs so as to enlarge or lessen the cavity of the chest, together with the current of the air itself, constitute the respiratory movements.

QUESTIONS.

What are the organs of respiration?
What conveys the air to the lungs?
What is the top of the trachea called?
What are the two large branches of the trachea called?
Can you describe their course in the lungs?
What are the air vesicles like?
In what compartment of the body are the lungs situated?
Can you state how far they extend?
Describe their internal structure.
What are lymphatics?
What are the air tubes and vesicles lined with?
What is the covering membrane of the lungs called?
By what vessels is the blood conveyed to the lungs?
What are their extreme branches called?
What are those arterial capillaries spread over?
By what means is the purified blood conveyed back to the heart?
Name the extreme branches of the four pulmonary veins.
What produce the respiratory movements of the chest?

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[4] *Capillaries*, their extreme branches.

[5] *Intercostal*, muscles between the ribs.

DESCRIPTION OF THE ORGANS OF RESPIRATION, &c.

PLATE 7.

1. The windpipe for conveying air to the lungs; or, the Trachea.
2. The branches of ditto; or, the Right and Left Bronchus.
3. The chief organs of Respiration; or, the Right and Left Lungs.
4. The chief organ of Circulation; or, the Heart.
5. The Aorta, forming an arch over the Heart and passing downwards.
6. The branches of the Aorta leading to the Head and Neck; or, the Carotid arteries.
7. The upper large branch of the Veins; or, the Superior Vena Cavæ.
8. The branches bringing back the blood from the Head, &c; or, the Jugular Veins.
9. The lower large branch of the Veins; or, the Inferior Vena Cavæ.
10. The vessel which conveys the blood to the Lungs; or, the Pulmonary artery.
11. The right and left branches of ditto.
12. The vessels for bringing back the blood from the Lungs; or, the four Pulmonary Veins.
13. A section of the bag which envelopes the Heart; the Pericardium.
14. The space between the Lungs; or, the Mediastinum.

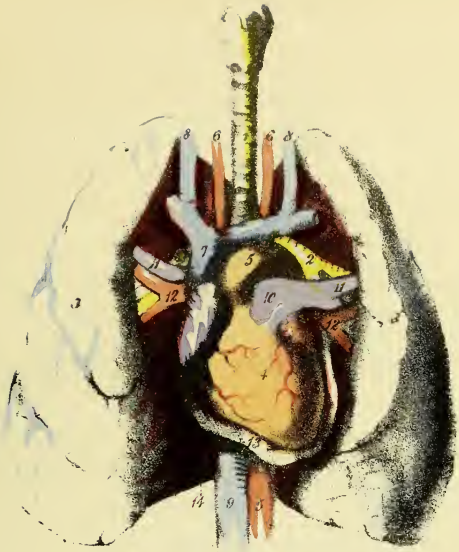
SECTION OF THE HEART.

1. The vessels which convey the venous blood to the Heart; or, the two Vena Cavæ.
2. The compartment into which it is first emptied; or, the Right Auricle.
3. The opening to the lower compartment on the right side, with the Tricuspid Valve.
4. The compartment from which it is forced into the Lungs; or, the Right Ventricle.
5. The vessel which conveys the blood to the Lungs to be purified; or, the Pulmonary Artery.
6. The vessels which convey the pure blood back from the Lungs; or, two of the Pulmonary Veins, (the other two being hid by other vessels).
7. The compartment into which the pure blood is emptied; or, the Left Auricle.
8. The opening to the lower compartment on the left side, with the Mitral Valve.
9. The compartment from which it is forced up into the Aorta; or, the Left Ventricle.

THE SIDE DIAGRAMS.

a. A section of a vein showing the Semi-lunar Valves in its interior.

b. Is intended to convey some idea of the manner in which the ultimate branches of the Pulmonary arteries and veins are spread out over the air vesicles of the Lungs.




a


b

LESSON XI.

RESPIRATION.

RESPIRATION, or breathing, is the process by which the air[1] is brought in contact with the blood so as to *purify it*, and at the same time to keep up the *animal heat* of the body.

The blood is purified by the *oxygen* of the air combining with the carbon[2] contained in the venous blood, forming the carbonic[3] acid gas which we pass out of the lungs in breathing; the *nitrogen* of the air also passing out in the form of gas.

The *heat* of the body seems to be generated by the oxygen of the air combining with the carbon of the blood, much in the same manner as the heat of the fire is kept up by the oxygen of the air combining with the carbon of the fuel.

When we *inspire*, or take air into the lungs, the diaphragm presses down upon the abdomen, and the intercostal muscles at the same time raise the ribs, thus enlarging the cavity of the chest so as to obtain a sufficient supply of air. The reverse movements take place when we *expire*, or expel the air from the lungs.

At the moment of inspiration a stream of venous blood

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[1] *The Air*, is composed of four parts of nitrogen gas, and one of oxygen, and a small portion of carbonic acid gas.

[2] *Carbon*, of the nature of pure charcoal.

[3] *Carbonic acid gas*, carbon and oxygen chemically combined.

is sent out *from the heart* to fill the arterial capillaries which are spread out over the air vesicles of the lungs, and the air rushing down into the air vesicles, its oxygen passes through their thin membraneous coats, and coming in contact with the blood, changes it instantly from venous into arterial.

At the moment of expiration the purified blood passes into the capillaries of the pulmonary[4] veins, and is carried by the four venous trunks *to the left side of the heart*, while at the same time the carbonic acid gas escapes through the coats of the blood-vessels into the air vesicles, from which it is expelled by expiration.

This expelled air, being of a poisonous quality, is unfit to be breathed over again.

Thus the process of respiration shows us the necessity for a constant supply of fresh air to purify the blood, as well as the necessity for getting rid of the impure air, which can only be done by well ventilating[5] our apartments.

The liver is also an organ that assists in purifying the blood by another process—that of secreting *bile* out of the venous blood.

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[4] *Pulmonary*, belonging to the lungs.

[5] *Ventilation*, a free admission of air.

QUESTIONS.

What is meant by respiration?
How is the blood purified?
Can you state what the air is composed of?
What is the proportion of nitrogen to oxygen?
What is meant by carbon?
What is carbonic acid gas?
How is the animal heat of the body kept up?
What is meant by inspiring and expiring?
Describe the movements of the chest in breathing.
At what moment is the blood sent to the lungs?
In what way does the liver help to purify the blood?
How is the blood purified in the air vesicles?
Where is the blood taken to when it is purified?
By what vessels is the blood taken back to the heart?
Into what compartment of the heart is the blood emptied?
What kind of air is expelled from the lungs?
What is this poisonous air composed of?
Why is pure air and good ventilation necessary to health?
In what organs of the lungs is the change effected?

LESSON XII.

SECRETION.

Secretion is one of those curious operations of nature by which different substances, required for various purposes in the body, are formed out of one fluid, the blood ; such as the saliva, gastric juice, bile, pancreatic juice, and many others.

The materials of all those different substances being chemically combined in the blood, secretion is the process by which each substance is elaborated[1] and prepared, each by its appropriate[2] organ, for the particular purpose required.

The organs of secretion are various in their structure; some being comparatively simple, and others exceedingly complicated.[3] Some of them are confined to a particular locality, as the liver, pancreas, and kidneys; and others are distributed throughout the body, as the glands of the skin, and those of the internal organs.

The *simplest form* of a secretory gland is seen in the *sebaceous follicles* of the skin. These are minute bag-like bodies, having their mouths outwards, in which is secreted the oily fluid for keeping the skin soft.

On the outside of these little bags, or follicles, are spread out the capiliary branches of the blood-vessels, and filaments[4] of the nerves. It is supposed that *secretion* is effected by the

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[1] *Elaborated*, heightened and improved.

[2] *Appropriate*, peculiarly fitted.

[3] *Complicated*, intricate, involved in one another.

[4] *Filaments*, their finest portion.

nerves stimulating[5] the arteries to elaborate the oily portion of the blood and pass it through the pores of these little membraneous bags into the interior; where it is stored up till required.

The secretion of other substances is supposed to be effected in a similar manner.

The *more complicated* glands of the body are however made up of vast numbers of some such simple organs; varying their forms and lengths in different glands. But whether they are in the form of cells, follicles, or branching tubes, each simple elementary organ has its branches of arteries, veins and nerves spread out over its surface; the whole of them being connected together, and enveloped in a membrane. Some of them are provided with vessels for containing the secretion, as well as ducts for conveying it to the part required.

The membranes lining the large compartments of the body *are not glanular*, but secrete a simple fluid by the agency of blood-vessels and nerves only.

QUESTIONS.

What is meant by secretion?
What are saliva, gastric juice, &c., formed out of?
By what process are they formed?
Can you name some of the organs of secretion?
Describe a secretory organ of the simplest form.
How is the secretion supposed to be effected in the sebaceous glands?
Can you describe a more complicated gland?
Do these simple forms vary in different glands?
What is the substance secreted by the liver contained in?
When the secretion is effected where does the blood go to?
Do parts of the body not glandular secrete?
Name some of those secretory membranes.
By what means are their secretions effected?

[5] *Stimulating*, exciting them to act.

LESSON XIII.

ABSORPTION.

Absorption is the process by which the nutritive[1] and waste materials of the body are taken up and conveyed to the parts required; as well as the process by which useful or pernicious[2] substances are taken into the circulation.

Nutritive matter, such as the chyle, is take up or absorbed by a set of vessels called the *lacteals*, and by them is conveyed to the mesenteric glands, and is finally emptied into the thoracic duct.

The *worn out particles* in different parts of the body are taken up by another set of absorbents,[3] called the *lymphatic vessels* and *glands;* the absorbed matter, called *lymph*, is likewise emptied into the thoracic duct.

Lymphatic vessels are minute transparent tubes accompaning the blood-vessels in their course through the body. They branch freely into each other but generally maintain the same size throughout; and, like the lacteals, transmit their contents through small bodies called the *lymphatic glands*. The lacteal and lymphatic vessels are each called absorbents.

But, in addition to these special organs of absorption for the removal of old and the introduction of new materials,

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[1] *Nutritive*, affording nourishment.
[2] *Pernicious*, injurious to health.
[3] *Absorbents*, organs for absorbing.

there are other parts of the body that more or less absorb; such as the skin, lungs, and blood-vessels.

The *skin* is proved to absorb, as various substances can be passed inwards by friction,[4] and as persons have been sustained for a time by nourishment absorbed through the skin.

That the *lungs* are very active absorbents, is shown by the rapid death of persons breathing poisonous fumes, and by the numerous diseases and deaths occasioned by living in a noxious[5] atmosphere.

The *blood-vessels* are also shown to be absorbents, as the vaccine[6] matter passed beneath the skin readily affects the whole mass of blood, and as poisonous substances dropped upon a vein or artery will speedily destroy life.

QUESTIONS.

What is meant by aborption?
In what way are those substances taken up?
How is nutritious matter generally absorbed?
State how the waste particles of the body are absorbed.
Can you describe the lymphatic vessels and glands?
What is the substance absorbed by the lymphatic vessels called?
What other parts of the body are said to be absorbent?
How is the skin shown to be an absorbent?
Describe how the lungs are shown to be so.
Can you state how disease is occasioned by bad air?
How are the blood vessels proved to be absorbent?
What is meant by vaccination?
Can you state why vaccination is useful?
Where do the lympatic vessels convey their contents?

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[4] *Friction*, rubbing.
Noxious, unhealthy.
[6] *Vaccine*, relating to cow pox.

LESSON XIV.

EXCRETION.

Excretion is the name given to that function by which all the rejected and noxious[1] materials of the body are removed out of it; the chief excretions being those of the skin, the lungs, liver, kidneys, and intestines.

The *skin* excretes or throws off a large proportion of the waste fluids of the body; in ordinary circumstances[2] from a pound and a half to two pounds daily, but in circumstances of great labour, in an heated atmosphere,[3] as much as from two to four pounds in an hour. This perspiration is salt, acrid,[4] and oily in its nature; aud to ensure health, should be daily removed from the skin.

The *lungs*, by the process of respiration, throw off, in the form of gas, the carbonaceous portion[5] of the blood; as well as a large portion of its moisture in the form of vapour.[6] It has been estimated that we send out from the lungs as much as from seven to fourteen ounces of solid charcoal, and from fifteen to twenty-four ounces of moisture, in every twenty-four hours.

The *liver* secretes bile from the venous blood, a fluid, which, after answering the two-fold purpose of promoting

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[1] *Noxious*, prejudicial, injurious.
[2] *Circumstances*, states, or conditions, around.
[3] *Atmosphere*, the air surrounding.
[4] *Acrid*, pungent and bitter.
[5] *Carbonaceous*, containing carbon.
[6] *Vapour*, an exhalation.

digestion and stimulating the action of the *intestines*, is excreted from the body with the innutritious portion of the food.

The *kidneys* not only secrete, and separate from the blood, a larger portion of its superfluous fluid, but also purify[7] it from a great variety of noxious substances highly injurious to health. The amount of labour, performed by those two small glands, may be estimated when physiologists declare that as much as a thousand ounces of blood pass through them in an hour.

To insure the health of the body, all the excretory organs must properly perform their respective functions; but still nature has wisely caused them to sympathise[8] with each other, so that in case either one of them be temporarily deranged, the other organs labour harder to remove the necessary excretion.

For instance, if the excretory functions of the skin are deranged by a cold, or otherwise, the lungs and kidneys will labour harder *than usual* in order to purify the system.

It may also be necessary to state that whenever we take more food than is required for the use of the body, we unjustly tax a number of organs to perform an extra degree of labour in order to get rid of the superfluity;[9] by which extra labour their functions become impaired, disease induced, and life shortened.

---

[7] *Purify*, to cleanse.

[8] *Sympathise*, to be affected by the state of another part.

[9] *Superfluity*, more than is wanted.

QUESTIONS.

What is meant by excretion?
Name the chief excretory organs.
What is perspiration secreted by?
Can you state the quantity secreted by the skin?
What is the nature of perspiration?
What takes place when the functions of the skin are deranged?
How is carbonaceous matter chiefly removed from the blood?
In what form is carbon removed?
What other matter is excreted by the lungs?
What is the quantity estimated to be?
What does the liver separate from the blood?
Describe the two-fold nature of the bile.
Can you state the functions of the kidneys?
What quantity of blood is estimated to pass through them in an hour?
What is meant by the excretory organs sympathizing with each other?
How are the excretory organs affected by the taking of too much food?

LESSON XV.

THE BRAIN AND NERVOUS SYSTEM.

The BRAIN and the NERVES connected with it are the organs of our sensations, thoughts, wishes, and will.

The brain is an oval-shaped medullary[1] body, filling up the cavity of the skull. It is secured in its place by means of a tough membrane called the *dura mater*, beneath which are two other coverings.[2]

It is divided, by folds of the dura mater, into two side portions or hemispheres,[3] and into an upper and lower portion; the upper and larger portion is called the *cerebrum*, and the lower and smaller portion the *cerebellum*.

The large branch of the nerves, connected with the brain, and enclosed in the cavity of the back-bone, is called the *spinal cord*,[4] the upper expanded portion of which is called the *medulla oblongata*. The nerves that branch out from each side of the brain and spinal cord, to different parts of the body, are soft white fibrous cords, formed of a number of exceedingly small tubes, said to contain a nervous fluid.

There are *nine pair* of nerves proceeding from the head, and *thirty-one pair* from the spinal cord.

The nerves which convey knowledge *to the brain*, through

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[1] *Medullary*, a soft brain-like substance.

[2] Called the *arachnoid membrane*, and the *pia mater*.

[3] *Hemisphere*, half of a sphere, or globe.

[4] *Spinal cord*, contained in the spinal column.

the organs of sight, hearing, smelling, tasting, and touching, are called *nerves of sensation.*[5]

The nerves which lead *from the brain*, which convey its will to every part, and stimulate the muscles to contract,[6] are called *nerves of motion.*

The nerves leading from the *ganglia*[7] on each side of the spinal cord, and which controul the functions of the internal organs, are called *the sympathetic or organic nerves.*

QUESTIONS.

What is the brain the chief organ of?
Name the cavity in which it is enclosed.
Can you name the bones on the skull?
What is the outer membrane of the brain called?
Can you name the two other membranes?
Can you name the two side divisions of the brain?
What are the names of the upper and lower divisions?
What forms the partitions between those divisions?
Name that portion of the nerves enclosed in the back bone.
What are the nerves like that proceed from the brain and spinal cord?
How many pair of nerves proceed from the head?
How many pair from the spinal cord?
What kind of nerves convey knowledge *to the brain?*
How many senses have you, and what are the organs of sense?
What kind of nerves proceed *from the brain* to the muscles?
What are the nerves called that controul the internal organs of the body?
Name the different portions of the nervous system.

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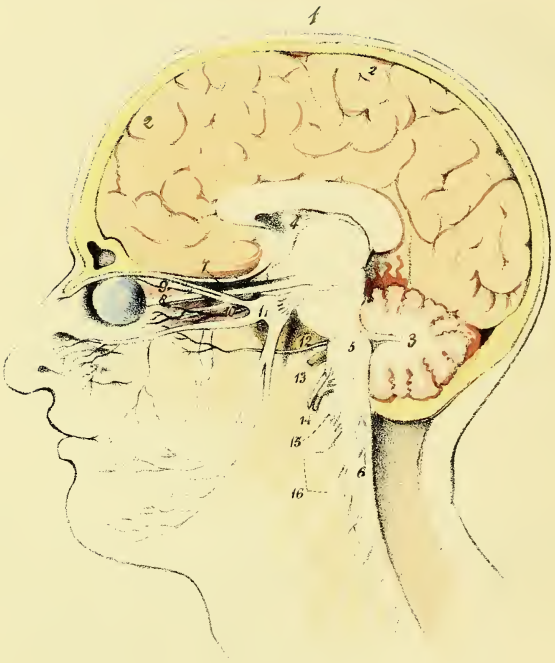
[5] *Sensation*, perception through the senses.

[6] *Contract*, to shrink from the ends towards the centre.

[7] *Ganglia*, nervous knots, varying in size.



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DESCRIPTION OF THE BRAIN AND CRANIAL NERVES.*

PLATE 8.

1. A section of the Brain, shewing its convolutions.
2. The upper and larger portion of the Brain; or, the Cerebrum.
3. The lower or little Brain; or, the Cerebellum.
4. The four cavities of the Brain; or, the Ventricles.
5. The expanded portion of the spinal cord within the skull; or, the Medulla Oblongata.
6. The chief trunk of the Nervous system; or, the Spinal Cord.
7. The first pair of nerves, those of smell; or, the Olfactory nerves.
8. The second pair, those of sight; or the Optic nerves.
9. The third pair, supplying the chief muscles of the eyes; or, the Common Motor nerves.
10. The fourth pair, supplying the muscles that roll the eyes; or, the Trochleares.
11. The fifth pair, being the great sensation nerves of the head and face; or, the Trifacial nerves.
12. The sixth pair, supplying the rectus externus muscles; or, the Abducentes.
13. The seventh pair, those of hearing; or, the Auditory nerves.
14. The eighth pair, sending branches to the lungs, heart, stomach, &c.; or, the Pneumogastric nerves.
15. The ninth pair, the motor nerves of the Tongue; or, the Lingual nerves.
16. The roots of some of the Cervical nerves.

THE MEMBRANES COVERING THE BRAIN.

The outer membrane—the Dura Mater.
The middle one—the Arachnoid membrane.
The inner one, the Pia Mater.

* For a fuller account of the Nervous System, see the Advanced Series of Lessons.

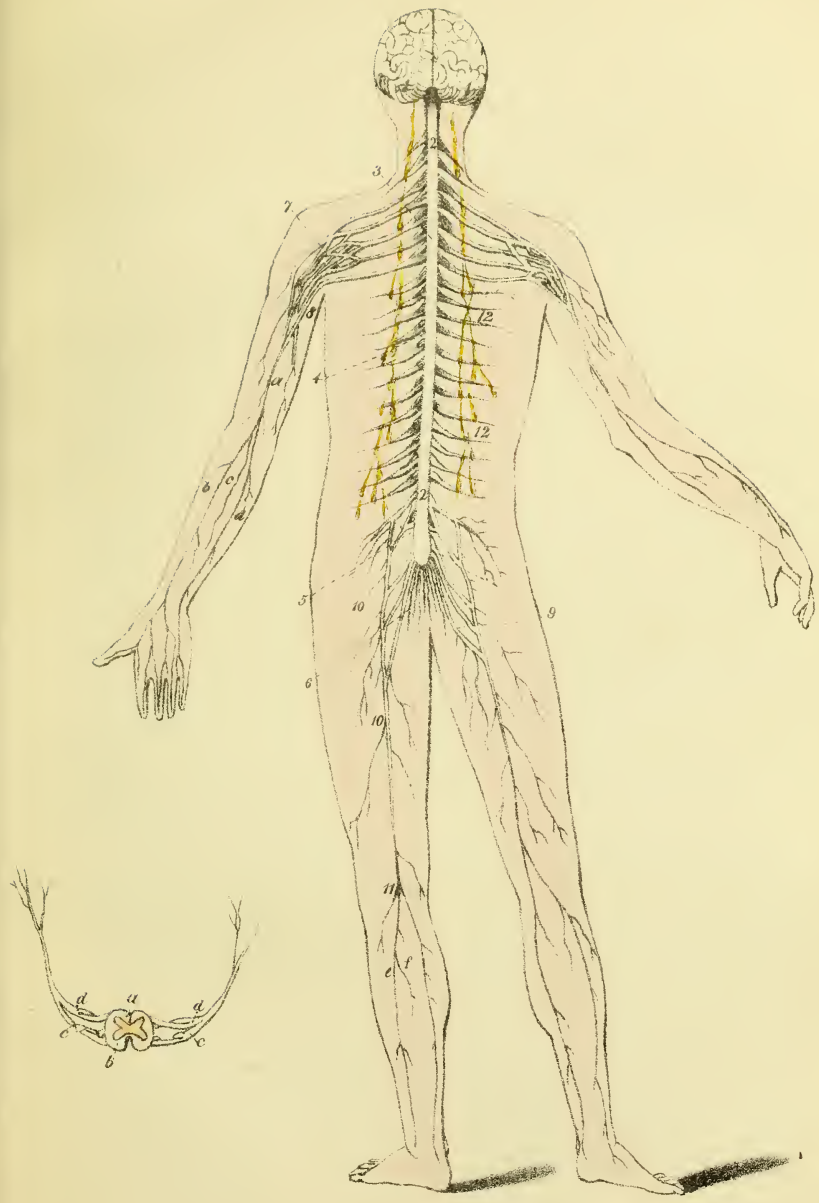
DESCRIPTION OF THE SPINAL NERVES, &c.

PLATE 9.

1. A back view of the Cerebrum and Cerebellum.
2. The Spinal Cord, or chief nervous trunk.
3. The eight Neck, or Cervical nerves.
4. The twelve Back, or Dorsal nerves.
5. The five Loin, or Lumbar nerves.
6. The six Sacrum, or Sacral nerves.
7. The union of nerves called the Brachial Plexus.
8. The Brachial nerve (*a*) dividing, forms the Radial (*b*), the Median (*c*), and the Ulnar (*d*).
9. The Lumbar Plexus, and Sacral Plexus.
10. The Great Ischiatic nerve, being the largest in the body.
11. The branches of the Ischiatic, called the Peroneal (*e*) and the Tibial (*f*).
12. The Ganglia and nerves of the Organic life, called the Sympathetic nerves.

THE SIDE DIAGRAM.

a. A section of the Spinal Cord.
b. The Cineritious matter in its interior.
c. The nerves of *sensation*, proceeding from the back of the cord.
d. The nerves of *motion*, from the front of it.



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LESSON XVI.

THE ORGANS OF SENSE.

The ORGANS OF SENSE are the inlets of information to the brain; being those of hearing, seeing, smelling, tasting, and touching.

The *ear* is the organ by which all sounds are transmitted to the brain; the air being the medium[1] by which they are conveyed. It is divided into an *external ear*, a middle portion or *drum*, and the internal *labyrinth*[2] on which the filaments of the nerves are spread out.

The *eye* is the organ of sight; and light[3] is the medium by which the forms and colours of objects are conveyed to it. It is a small globular body, covered with three membranes, and filled with three different transparent substances, called the *humours*[4] of the eye. The circular membrane in front, forming the colour of the eye, is called the *iris*,[5] and the small hole in its centre, for the admission of light, the *pupil*. The front and outside membrane of the eye is called the *cornea*.

The *nose* is the organ of smell, and the air is the medium by which odorous particles are conveyed to its interior. Within the nostrils are several passages, lined with a pulpy membrane, on which the filaments of the nerves are spread out.

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[1] *Medium*, the thing used to convey it.

[2] *Labyrinth*, a part having many winding cavities.

[3] *Light*, a fluid vibrating between the sun and the earth.

[4] *Humours*, called the aqueous, the crystaline, and vitreous humours.

[5] *Iris*, the circular curtain round the pupil of the eye.

The *tongue* is the chief organ of taste, over the surface of which are spread out the papillæ of the nerves. The substance tasted, being partially dissolved by the saliva, is pressed by the tongue against the roof of the mouth, so as to more fully impress the nerves with its peculiar taste.

The *hands and fingers* may be said to be the especial organs of touch; being more sensitive and discriminating than other parts of the body. We feel by means of the *nerves of sensation;* their extremities terminating in little nervous papillæ[6] all over the surface of the body. The papillæ are larger on the tips of the fingers than on other parts of the body, and form the minute ridges we see on them.

QUESTIONS.

What is meant by the organs of sense?
How many organs of sense do we possess?
Can you state how sounds are conveyed to the ear?
How are the sensations of sound conveyed to the brain?
Describe the different parts or divisions of the ear.
How are the forms and colours of objects conveyed to the brain?
By what medium are they conveyed to the eye?
What is the globe of the eye covered with?
Can you state what it is filled with?
What membrane forms the colour of the eye?
By what part does the light enter the eye?
How is the sensation of smell conveyed to the brain?
What is it that carries the odorous particles to the nose?
Can you state how the variety of tastes is conveyed to the brain?
What is necessary in order to taste?
What is meant by nervous papillæ?
With what parts of the body do we feel?
Name the especial organs of touch.

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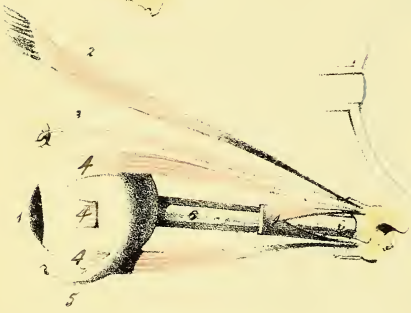
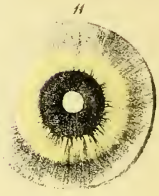
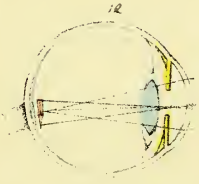
[6] *Nervous papillæ*, little cone-like projections formed by the ends of the nerves pushing up the outer skin.







DESCRIPTION OF THE ORGANS OF SENSE.

PLATE 10.

OF HEARING.

1. The External Ear for collecting the sound.
2. The Tube which conveys it inwards.
3. The Middle portion of the Ear, called the Tympanum, or Drum.
4. The Membrane of the drum on which the sound strikes.
5. The Bones of the Ear which convey the vibrations inwards.
6. The Eustachian Tube, which conveys air to the interior of the drum.
7. The Internal Ear, or Labyrinth.
8. The parts of the Labyrinth; (*a*) the Vestibule, (*b*) the semi-circular Canals, (*c*) the Cochlea.
9. Section of the Labyrinth showing its pulpy membrane, on which the filaments of the Auditory nerve are expanded.

OF SEEING.

1. The Globe of the Eye, with its different muscles.
2. The Levator Palpebræ, for raising the upper eyelid.
3. The Obliquus Superior, or Trochlearis.
4. The four Recti muscles.
5. The Obliquus Inferior.
6. The Optic nerve, with its coverings.
7. Section of the Eye, shewing its Coatings and Humours.
8. The Cornea, behind which is the aqueous humour in which the Iris floats (*a*).
9. The Crystalline humour, in the form of a double convex lens.
10. The Vitreous humour, at the back of which is seen the Optic nerve.
11. Section showing the Iris and Pupil from within.
12. Section showing how an object is reflected on the Retina.

OF SMELLING.

1. A longitudinal Section of the Nose.
2. The filaments of the Olfactory nerve expanded on the Pituitary membrane.
3. The Frontal Sinus.
4. The Section of the hard and soft Palates.
5. The Upper portion of the Pharynx.
6. The Entrance of the Eustachian tube.

OF TASTING.

1. The Tongue, showing its nervous Papillæ.
2. The Hyo-glossus muscle,
3. The Genio-glossus muscle,
4. The Stylo-glossus muscle,
5. The Lingualis muscle,

(2–5) Muscles for moving the Tongue in all directions.

6. Shows one half of the lower Maxillary bone.

OF TOUCHING.

1. A magnified view of the nervous extremities on the front of the Finger,
2. Shows where the Mucus coat has been removed from the nervous Papillæ,
3. The loop-like form of the nerves of touch in the skin of the Finger.

ADVANCED SERIES OF LESSONS.

LESSON I.

THE BONES, &c.

The Skeleton, or solid framework, which supports our bodies, and to which our various muscles are attached, is made up of 246 bones, joined, or articulated, to each other by 180 different joints; the whole secured in their position by extremely tough ligaments.

These bones are of various and peculiar forms, wonderfully fitted to each other, combining lightness with the greatest strength and freest motion; and admirably contrived for securing and protecting all the delicate and important organs within our frames, as well as for shielding us from injuries from without.

In order to facilitate the description of this bony framework, *Anatomists* generally classify or divide it into three great divisions; the bones of the head forming the first division, of the trunk the second, and the extremities, or limbs, the third.

The bones of the head are those of the cranium, or skull, and those belonging to the face. The *skull*, in which the

brain is enclosed, is formed of eight[1] bones, the upper ones arched and curiously united together, so as to admit of the free growth of the brain; and the bony walls and joints are so constructed as to best protect that important organ in case of sudden blows.

The bones of the *face* are those of the cheeks, jaws, nose, and mouth, and are fourteen[2] in number; which, with the cutting, crushing, and grinding teeth (amounting, in an adult person, to sixteen in each jaw), complete the bones of the head.

The TRUNK includes the back-bone, the ribs, the breast-bone, the shoulder-bones, the collar-bones, and the pelvic, or hip-bones.

The *back-bone*, or spinal column, is made up of twenty-four separate bones; the seven[3] upper ones being the neck-bones, the twelve[4] below them the back-bones, to which the ribs are attached behind, the five[5] next being the bones of the loins.

The *rib-bones*, twelve on each side of the body, are

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[1] The bones of the *skull* are—
The Frontal bone,
The two Temporal bones,
The two Parietal bones,
The Occipital bone,
The Ethmoid and Sphenoid bones.

[2] The bones of the *face* are—
The two nose, or Nasal bones,
The two cheek, or Malar bones,
The two upper jaw, or superior Maxillary bones,
The lower jaw, or inferior Maxillary bone,
The two Lachrymal bones in the orbits of the eyes,
The two Palatine bones in the roof of the mouth,
The two Turbinated bones in the sides of the nose,
The Vomer, which separates the nostrils.
There is also a small bone to which the *tongue* is attached, called the Hyoides.

[3] The seven neck, or Cervical bones.
[4] The twelve back, or Dorsal bones.
[5] The five loin, or Lumbar bones.

somewhat of a semi-circular form; they are united behind to the spinal column by exceedingly tough ligaments, and are attached to the breast-bone in front by a strong gristly substance called cartilage. They unitedly form the hollow cavity of our bodies called the thorax, or chest, and are so united as to move upwards and downwards with every breath we draw.

The five lower ribs, on each side, being first united to each other by separate bands of cartilage, and these attached to the breast-bone[6] by a single band, are called *false ribs*, to distinguish them from those which, being fixed singly to it, each by a separate band of cartilage, are called *true ribs*.

The two *shoulder-bones*, to which the arms are attached, are two[7] large triangular bones buried in the muscles of the shoulders, and extending from the second to the seventh ribs. At the large angle of each of those bones is a cup-like cavity, into which the round portion of the arm-bone is inserted to form what is called a "ball and socket joint;" that is, a joint capable of being moved in almost every direction.

The *collar-bones*,[8] one on each side, extend from the large angle of the shoulder-bone to the top of the breast-bone, to which they are firmly attached, for the purpose of affording greater strength and support to the shoulders and breast-bone.

The *four pelvic*,[9] or *hip-bones*, unitedly form the basis of the trunk, in the hollow cavity of which are contained

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[6] The breast-bone, or Sternum.

[7] The two shoulder-bones, or Scapulæ.

[8] The two collar-bones, or Clavicles.

[9] The Pelvis is formed of the two Innominata, the Sacrum, and the Cocyx, or Point of the Spine.

a portion of the large intestines, the bladder, and parts of other organs. At the under and outer surface of the two side-bones are two large circular cavities, into which the rounded tops of the thigh-bones are inserted, thus forming "ball and socket joints."

The EXTREMITIES are the arms and hands, and the thighs, legs, and feet; distinguished as the upper and lower extremities.

Each *arm* contains three cylindrical[10] bones, the largest one in the upper part of the arm, called the upper arm, and the other two forming the lower, or fore-arm. The wrist, to which the fore-arm bones are attached, consists of eight[11] small bones, placed in double rows, and so joined to each other as to admit of a great variety of movements.

The *hand* is formed of five[12] bones, nearly parallel to each other, the one to which the thumb is joined being the shortest. The fingers,[13] which are joined to the ends of the hand-bones, are each formed of three bones, excepting the thumb, which has only two; in all, fourteen finger-bones to each hand.

Each *thigh* contains a single[14] cylindrical bone, the largest and strongest in the whole frame.

The *legs* have each two[15] bones; those joined to the lower portion of the thigh-bone, form the knee, to the front of which is attached a small bone[16] for protecting the knee-joint.

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[10] The upper arm, or Humerus, and the two fore-arm-bones, or the Radius and Ulna.

[11] The eight wrist, or Carpal bones.

[12] The five hand, or Metacarpal bones

[13] The fourteen finger-bones, or Phalanges of the hand.

[14] The thigh-bone, or Femur.

[15] The two leg-bones, or the Tibia and Fibula.

[16] The knee-bone, or Patella.

lower parts of the leg-bones are joined to seven[17] bones, which form the heel and instep of the foot, arranged so as to form a strong arch in front.

The bones of the instep are joined to five[18] bones, which form the sole, or middle of the foot, to the ends of which are joined the toes. The toes,[19] like the fingers, have each three bones, excepting the great toe, which has only two.

All the various joints of the body are bound to each other by strong *ligaments*, so tough that the bone will generally break before the ligament will give way.

Where the bones meet to form movable joints, the ends are covered over with a smooth, white, gristly[20] substance, so that they may move freely one over the other; the parts are also lubricated by means of a fluid[21] secreted by a membrane contained in each joint. Between each joint of the back-bone there is also a thick layer of a soft gristly substance, forming a springy cushion, to prevent the brain and spinal-cord from being injured by any concussion or sudden blow.

The bones are supplied with blood-vessels, nerves, and lymphatics, to enable them to derive growth and nutriment from the blood, though these organs are not so numerous as in many other parts of the body.

When a bone is broken, if it be properly *set*, or the parts placed against each other, the ends of the fractures readily secrete bony matter for cementing them again.

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[17] The seven instep, or Tarsal bones.

[18] The five foot, or Metatarsal bones.

[19] Fourteen toe-bones, or Phalanges of the foot.

[20] Called Cartilage.

[21] Called Synovia.

The bones are composed, for the most part, of *phosphate of lime* and *gelatine*, with a minute portion of other earthy and animal substances. In infancy the gelatine preponderates, so that children require careful nursing and proper food to prevent their soft limbs from becoming crooked and deformed. In old age the lime preponderates, so that the bones of old people become very brittle and more difficult to unite again when any part is broken.

In the formation and growth of bones, the ossification, or the deposit of the hard bony matter, generally begins at a central spot, and radiates towards the extremities.

The bones of the teeth are harder and denser than other bones, being of the nature of ivory; the surface of them are also covered over with a crystalized substance called *enamel*.

LESSON II.

THE MUSCLES, &c.

The MUSCLES are those fleshy fibrous cords and layers, which are attached to the different bones of our body, for the purpose of moving them in such direction *as the will dictates;* as also the fleshy or membraneous substance of those internal organs which move and perform their functions *independent of the will.*

Those muscles which are under the controul of the will, as those are which move our limbs or bodies, are called *voluntary muscles.* Those which act without consulting us, as the heart, stomach, intestines, &c., are called *involuntary muscles.* Those which generally act without our attention, but which we can controul for a short time, as the muscles of respiration &c., are of *a mixed character.*

There are about 512 muscles belonging to the body, 368 of them in pairs. They are of different lengths, forms, thickness and power, according to the functions they have to perform, or the situation of the body in which they may be placed; the great object in their arrangement seems to be for combining strength and rapidity, with beauty of form, and grace of motion.

The muscles are formed of exceedingly minute *fibres,* of a nature allied to the fibrous portion of the blood, and each fleshy cord, composed of those fibres, has the power of *contraction* imparted to it by means of the blood and nervous

influence; for if the one be impeded or the other cut the muscle will speedily become paralysed.

A number of these *fibrous cords* united together, and enclosed in a thin delicate sheath of membrane, are called *fasciculi;* and a number of these united together in a common sheath, with cellular tissue and fat between them, compose *the body of the muscle.* By this arrangement the different parts of the muscle move, or glide, freely one over the other in all their contractions.

The extremities of muscles, or those parts by which they are attached to the bones, are called *tendons*; these are generally smaller and tougher than the middle or belly of the muscle, and are composed of hard, dense, and exceedingly white fibres.

The muscles are abundantly supplied with blood-vessels, lymphatics, and nerves, which are seen traversing the most delicate membrane of the most minute parts.

Almost every muscle has its antagonist, or opposing muscle; thus, in our arms and legs, we have one set of muscles to enable us to bend, and another set to extend them, the former are called *flexor*, and the latter *extensor* muscles.

The mode by which a voluntary muscle acts is supposed to be as follows. The *desire of the brain,* to move any limb or part of the body, is conveyed or made known to the muscles of that particular part *by the nerves which branch through them;* called the *nerves of motion.* The will at the same time imparting its influence through the nerves, stimulates every nervous filament to shrink or contract, and these filaments pervading every part of the muscular fibre cause the whole muscle likewise to *contract;* that is to shrink

from both ends towards the middle, by which means the limb to be moved is drawn towards the fixed point to which the muscle is attached.

The muscles, like the bones, are divided or classified into those of the HEAD, TRUNK, and EXTREMITIES; but as one set of muscles are sometimes attached to two of those divisions the classification is not so distinct.

The muscles of the HEAD are those of the skull and face.

The *skull* has one[1] broad thin muscle expanded over it, for the purpose of moving the scalp of the head and giving expression to the forehead On each side of the skull are three[2] small muscles, for moving the external parts of the ears; as also the attachments of the large muscles of the lower jaw.

The muscles of the *face* comprise those of the jaws, eyes, nose, and lips; as well as some of the attachments of the muscles of the neck.

The jaws are moved in all their directions by means of five[3] pairs of muscles; some of them of exceedingly great power.

Each eye has six[4] curiously constructed muscles attached to different parts, for moving it in all the variety of positions of which we are capable. There are also two[5] muscles be-

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[1] The Occipito-frontales.

[2] The Altollens aurem,
The Attrahens aurem,
The Retrahens aurem.

[3] The Masseter,
The Temporalis,
The Pterygoideus externus,
The Pterygoideus internus,
The Digastricus.

[4] The Rectus superior,
The Rectus inferior,
The Rectus internus,
The Rectus externus,
The Obliquus superior, or the Trochlearis,
The Obliquus inferior.

[5] The Orbicularis palpebrarum,
The Levator palpebræ superioris.

longing to each eyelid; one, a broad thin muscle, encircling the orbit of the eye, for the purpose of closing the eyelids; and the other, a long thin muscle, attached to the back of the orbit, for the purpose of raising the upper eyelid. There is likewise a small muscle,[6] on the arch of each orbit, for drawing the eyebrows towards the nose, as seen in persons frowning.

The nose has four[7] muscles attached to it, which, with the cartilaginous parts, give it form and expression; two of them are for dilating and one for compressing the nostrils.

The lips are principally formed by the oval[8] muscle which encircles the mouth, enclosed in the outward skin and inner membrane; they are open and shut, contracted and drawn in all their various positions, by means of nine[9] different muscles on each side.

The muscles of the TRUNK are those of the back, neck, chest, and abdomen.

The *back* is covered with six different layers of muscles, each moving freely one over the other. The deep-seated are the smallest and most numerous, and are adapted for giving support and motion to the neck, back, and ribs. The outward layer consists of two[10] broad thin muscles,

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[6] The Corrugator supercilii.

[7] The Pyramidalis nasi.
The Compressor nasi,
The Levator labii superioris alaeque nasi,
The Depressor alae nasi.

[8] The Orbicularis oris.

[9] The Levator labii superioris,
The Levator anguli oris,
The Zygomaticus major,
The Zygomaticus minor,
The Buccinator,
The Depressor anguli oris,
The Depressor labii inferioris,
The Levator menti,
The Levator labii superioris alaeoque nasi.

[10] The Trapezius,
The Latissimus dorsi.

nearly covering the back, the upper one for drawing back the head and shoulders, and the lower one for drawing the arms downwards when raised.

The *neck* is supplied on each side with two[11] superficial muscles, the one broad and thin, forming the skinny folds of the neck, and the other an oblique tendonous muscle, for turning and bending the head. There are also several deep-seated ones on the neck which give support to the head and aid its different movements.

The movements of the *tongue* are chiefly effected by means of four[12] principal muscles, while eight[13] others support and move the bone to which it is attached. These last serve to move the tongue-bone in different directions, to control the *larynx*, or vocal organ, and to aid in depressing the lower jaw.

To also aid the tongue in gathering up the food during mastication, for passing it backwards into the *pharynx*, or top of the food-pipe, as well as for assisting to modulate the voice, five[14] palate muscles are provided; while four[15] others,

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[11] The Platysma myoides,
The Sterno-cleido mastoideus.

[12] The Hyo-glossus,
The Genio-glossus,
The Stylo-glossus,
The Lingualis.

[13] The Digastricus,
The Stylo-hyoideus,
The Mylo-hyoideus,
The Genio-hyoideus,
The Omo-hyoideus,
The Sterno-hyoideus,
The Sterno-thryoideus,
The Thyro-hyoideus.

[14] The Circumflexus palati,
The Levator palati,
The Levator uvulæ,
The Palato pharyngeus,
The Constrictor isthmi faucium.

[15] The Constrictor pharyngeus inferior,
The Constrictor pharyngeus medius,
The Constrictor pharyngeus superior,
The Stylo-pharyngeus.

covering the back and sides of the pharynx, serve to force the food downwards in the act of swallowing.

The *chest* is covered on each side with four[16] large muscles, two of them for drawing the arms towards the chest, and two for giving support to the shoulder and for assisting in forced respiration. The interior of the chest is separated from the abdomen by means of a thin muscle called the *diaphragm*, which, with the ribs and the muscles[17] between them, form the principal apparatus for expanding the chest in breathing.

The *abdomen* is covered with five[18] pairs of muscles, their use being to draw the ribs downwards, bend the chest upon the abdomen, and compress the cavity of the bowels.

The muscles of the EXTREMITIES are those of the shoulders, arms, and hands; and of the thighs, legs, and feet.

The arm, at the *shoulder*, is raised and moved in its various positions chiefly by means of eight[19] powerful muscles; the chief, and most important one, on the shoulder, five others rising from the back and shoulder bone, and two from the chest.

The *arm* is flexed, or bent, at the elbow, by means of

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[15] The Pectoralis major,
The Pectoralis minor,
The Subclavius,
The Serratus magnus.

[17] The Intercostales externi,
The Intercostales interni,
The Levatores costarum,
The Triangulares sterni.

[18] The Obliquus abdominis externus,
The Obliquus abdominis internus,
The Transversalis abdominis,
The Rectus abdominis,
The Pyramidalis.

[19] The Deltoides on the shoulder.
The Supra-spinatus,
The Infra-spinatus,
The Teres major,
The Teres minor
The Subscapularis,
} On the back, &c.
The Pectoralis major.
The Pectoralis minor.
} On the chest.

two[20] muscles placed on the fore part of the upper arm ; and extended by means of two[21] others on the back of it. There are also four[22] muscles provided for enabling us to turn or twist the arm, so as to turn the palm of the hand up or down.

The *hand* and fingers are bent chiefly by means of two[23] muscles placed on the front of the fore-arm and hand, and extended by means of one[24] muscle situated on the back of the arm and hand.

These muscles are separated each into four divisions, and where they are attached to the fingers they curiously end in sheaths and tendons ; the tendon for bending one joint running through the sheath enclosing another joint. There are also several other small muscles belonging to the thumb and fingers to enable them to execute all their varied movements.

The *thigh*, at the hip-joint, is bent upon the body chiefly by means of two[25] powerful muscles on each side, attached to the pelvic and lumbar bones ; and is extended by means of three[26] large muscles situated behind. The thigh is also rotated and turned inwards and outwards by means of a number of other powerful muscles.

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[20] The Biceps flexor cubiti,
The Brachialis internus.

[21] The Triceps extensor cubiti,
The Anconeus.

[22] The Suppinator longus,
The Suppinator brevis,
The Pronator teres,
The Pronator quadratus

[23] The Flexor digitorum sublimis, vel perforatus,
The Flexor digitorum profundus, vel perforans.

[24] The Extensor digitorum communis.

[25] The Psoas magnus and parvus,
The Iliacus internus.

[26] The Gluteus maximus,
The Gluteus medius,
The Gluteus minimus.

The mass of muscle on the thigh-bone consists, for the most part, of the muscles for bending and extending the leg at the knee-joint. On the back of the thigh are three[27] large muscles for bending the *leg*, and on the front of it are four[28] large ones for extending it. There is also a thin oblique[29] muscle, on each thigh, for crossing the legs one over the other.

The *foot* is bent by means of two[30] muscles on the front of the leg, and extended by means of three[31] others forming the calf, the lower ends of which unite to form the large tendon at the heel, called the *tendon of Achilles*. There are also two[32] other muscles on the outer side of the leg, which enable us to turn our foot outwards; and a deep-seated[33] one behind which aids in bending the foot and turning it inwards.

The *toes* are bent by means of two[34] long muscles placed beneath the calf, and a short one[35] placed beneath the foot, the lower ends of which divide into tendons leading to the toes, in a similar manner to those of the fingers. The toes are extended by means of two[36] muscles on the front of the

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[27] The Biceps femoris,
The Semitendinosus,
The Semimembranosus.

[28] The Rectus femoris,
The Crureus,
The Vastus internus,
The Vastus externus.

[29] The Sartorius.

[30] The Tibialis anticus,
The Peroneus tertius.

[31] The Gastrocnemii,
The Plantaris,
The Soleus.

[32] The Peroneus longus,
The Peroneus brevis.

[33] The Tibialis posticus.

[34] Flexor longus digitorum pedis,
Flexor longus pollicis pedis.

[35] Flexor brevis digitorum pedis.

[36] Extensor longus digitorum pedis,
Extensor proprius pollicis pedis.

leg, and a short[37] one on the back of the foot, which likewise end in sheaths and tendons running through each other.

The muscles of the upper and lower extremities are enclosed in a strong tendinous sheath[38] for affording them additional strength and protection. Tough ligaments are also bound round the wrists, palms of the hands, and insteps of the feet, for retaining the muscular tendons in their proper place.

In contemplating the organization, arrangement, and power of those innumerable living cords which, unitedly, compose the muscular structure, we must not fail to remember that *exercise is the most important law of their nature.*

By *proper exercise* the blood is impelled onwards in its course, nourishing, expanding, and strengthening each fibrous thread, and giving energy both to mind and body. For the want of such exercise the muscles shrink, their power becomes weakened, and the whole mental and bodily system relaxed.

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[37] The Extensor Brevis digitorum pedis.

[38] The Fascia, or Aponeurosis.

LESSON III.

THE SKIN—ITS FUNCTIONS.

The SKIN is the tough elastic membrane enveloping the *external* portions of the body; serving to keep the various muscles in their position, to pass off some of the excretions, and to protect from cold and injury the innumerable blood-vessels, nerves, and glands, spread out under its surface.

This covering is also called the *cutaneous membrane*, to distinguish it from the *mucous membrane*, which is continuous with it, but which passes inwards to *line* the internal cavities and organs of the body; as well as from the *serous membranes*, which envelope or *cover* most of the internal organs.

The skin is composed of three distinct layers, one over the other; the outer one called the CUTICLE, or scarf skin, the middle layer the RETE MUCOSUM, or mucous network, and the under one the CUTIS, or true skin; though some physiologists consider the middle, or mucous layer, as belonging to the one beneath it.

The *cuticle*, or outer skin, is a thin semi-transparent membrane, which, being destitute of nerves, can be cut or pierced without pain. It is thickest on the palms of the hands and soles of the feet, and becomes thicker on any part of the body in proportion as this is subject to pressure. It consists chiefly of albumen[1] in a solid state, and is of the

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[1] *Albumen*, the substance which forms the serum of the blood, the white of eggs, &c.

same nature as the nails of the fingers and toes, which are hardened parts of the cuticle.

The substance which forms this outer membrane is exuded in a fluid state from the true skin, and as it hardens assumes an organized form. When examined by the microscope it appears to be made up of minute scales, united together by a delicate membrane, and is so constructed as to admit of substances passing out and in between the scales; the openings being connected with the excretory and absorbent vessels.

The *rete-mucosum*, or middle layer of the skin, is a soft, mucous, or viscid fluid; its use being to protect the delicate vessels beneath, and to keep the nerves of touch, which pass through it, soft and pliable. It also constitutes the colouring matter of the skin; being dark in the Negro, yellowish in the Asiatic, reddish in the American Indian, and nearly colourless in Europeans.

It is secreted by minute glands in the membrane beneath, and some of these contain the colouring matter spoken of; to the different combinations of which is attributed *all the variety of colour* in birds, beasts, and fishes.

The *cutis*, or true skin, is the inner layer; it is a thick fibrous membrane, abounding in nerves, arteries, veins, glands, and other vessels. The upper surface of it is a complete net-work of vessels and nerves; the extremities of which, coursing through the mucous coating, terminate in the cuticle, by which covering their extreme sensitiveness is blunted. Those minute vessels and nerves are so numerously spread out over the surface that the point of the finest needle cannot be inserted without producing blood and causing pain, proving that some blood-vessel and nerve must be injured.

The extremities of the nerves of the skin constitute the

organs of touch. These may be seen at the points of the fingers, when the sense of touch is greatly excited, pushing out the cuticle in the form of minute protuberances. They may likewise be seen, in a greatly depressed form, in what is called "goose-flesh," when the skin is chilled by sudden cold.

Throughout the cutis are also placed innumerable little glands for secreting, from the blood, the various matters that are passed off through the pores of the skin by visible and invisible perspiration. Also the minute glands[2] that secrete the oily fluid for lubricating and softening the skin, as well as the vessels connected with the absorbents. The bulbs or roots of the hair are also situated in the skin, each hair being a horny tube containing a soft medullary fluid, varying in colour in different individuals. To the skin, *as a whole*, then, belong the following important functions.

1st. It is *an organ of the sense of touch;* those parts of the body most sensitive being the hands, fingers, tongue, and lips. This sense is effected by means of the extreme branches of the *nerves of feeling*, which, rising up from the surface of the true skin, in little loop-like filaments, form minute protuberances under the cuticle, called *nervous papillæ*, or little paps, every one of which is nourished and stimulated by branches of the blood-vessels.

2nd. It is *an organ of secretion;* as it secretes or separates from the blood the waste or noxious fluid called perspiration or sweat; as also the oily fluid for softening the skin.

3rd. It is *an organ of excretion;* as it passes off the perspiration through the outward pores, by means of small

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[2] The *sebaceous* glands.

spiral ducts leading up from the glands[3] in which it is secreted. It also excretes or passes outward the oily fluid prepared by secretion.

4th. It is *an organ of absorption;* as it draws in, and passes into the general circulation of the blood, many substances brought in contact with it. The power of absorption is greatly blunted by the cuticle, or we could not so handle noxious substances with impunity; but still we find that many substances are absorbed when the skin is warm and moist, and more especially when gentle friction is applied, as is sometimes done for passing medicines through. When, however, the cuticle is lifted up or altogether removed, substances are very actively absorbed, as is seen in cases of inoculation, vaccination, bites of venomous animals, and when poisonous substances are dropped upon excoriations.

The pores of the body are so numerous that upwards of two thousand of them are found in the compass of every square inch. Calculations have also been made, from experiments, that as much as from a pound-and-half to two pounds of a salt acid oily fluid pass off through the pores of the body, by invisible perspiration, every twenty-four hours; and that as much as from three to five pounds of visible perspiration, or sweat, are passed off, in one hour, from a person working very hard in a hot place. It has also been estimated, that out of every 96 ozs. of food taken into the body, about 34 ozs. of it are passed out again through the pores of the skin.

The skin, therefore, being to such an extent an *exhalant,* or perspiring organ, if its vessels are by any means obstructed, the work of passing off this large amount of refuse matter

[3] The *Sudoriparous* glands.

must necessarily be thrown upon other organs, such as the kidneys, bowels, and lungs, by which means inflammation or other disease of those organs frequently occurs. But if these organs are in any way debilitated, so as to be incompetent to the task of performing double labour, the noxious substances must be retained in the system, and so produce disease.

The skin being also an active *absorbent*, readily takes into the circulation, under certain conditions of temperament, any noxious ingredient left on the surface of the body; as well as any impure vapour, or poisonous gases, by which it may be surrounded.

The skin, being likewise an *organ of touch*, is very liable to suffer by exposure to damp and cold; as the blood is thereby driven from the surface of the body to overpress and injure the internal organization. It also suffers from the want of proper exercise and warm clothing, as well as from every cause which prevents or checks the requisite supply of blood for nourishing and stimulating the millions of nervous papillæ that are spread out over its surface.

Such being the principal functions of the skin, they convey to us important lessons; teaching us the great necessity that exists for keeping its surface free from all impurities, by personal cleanliness and frequent bathing—for stimulating and keeping its numerous blood-vessels in healthy circulation, by proper exercise and the daily use of the flesh-brush or coarse towel—for keeping its delicate nerves, glands, and vessels protected from cold and damp, by warm and comfortable clothing—and for living in a dry, light, well-ventilated dwelling, with an ample supply of water for all the purposes of cleanliness and health.

LESSON IV.

THE INTERIOR OF THE BODY.

The organs and parts in the interior of the body will be best understood if described under the divisions of the HEAD, NECK, and TRUNK.

The organs of the HEAD are the brain, or organ of our thoughts and feelings; the four organs of sense, namely, of hearing, seeing, smelling, and tasting; as also the organs for masticating our food; being the mouth, teeth, and salivary glands.

In the NECK, or upper portion of the trunk, are contained the larynx, the trachea, the pharynx, the esophagus, the upper portion of the spinal cord, and those branches of the veins and arteries which convey the blood into and out of the head.

The *larynx* is the organ of voice; it forms the upper part of the *trachea*, or wind-pipe, which is the cylindrical tube, situated in front of the neck, for conveying the air down to the lungs.

The *pharynx* is that membranous bag which is situated immediately behind the wind-pipe, into which the food is passed from the mouth in the act of swallowing; it forms the upper part of the *esophagus*, the tube which conveys the food down to the stomach.

The *spinal cord* is that large branch of the nerves, proceeding downwards from the brain, which is enclosed in the cavity of the back-bone.

The vessels which convey the pure blood to the head are called the *carotid arteries*; those which take back the impure blood to the heart are the *jugular veins*.

The TRUNK is divided into two compartments, an upper and a lower, by means of a thin muscle called the *diaphragm;* this is attached to the end of the breast-bone, the lower ribs, and lumbar-bones, in such a manner as to partially move up and down in the process of respiration.

The upper compartment, or portion above this partition, is called the THORAX, or chest; and the lower compartment the ABDOMEN, or belly.

The THORAX contains the lungs, and lower portion of the tube which supplies them with air; also the heart, and the large branches of the arteries and veins connected with it.

The *lungs*, or organs of respiration, are two spongy bodies, situated one on each side of the chest, with the heart between them. They extend in length from about the first rib to the diaphragm, on which they rest. They partake of the conical form of the interior, and with the heart and vessels fill up the cavity.

Nearly half way down the chest the trachea is separated into two branches, called the *bronchi;* one branch entering the right lung, and the other the left.

A thin, smooth, white, serous membrane, called the *pleura*, lines the interior of the chest. A portion of it is brought round each lung, so as to envelope it, and lie upon it as a bag. This membraneous envelope also secretes into itself a fluid for keeping its inner surface soft and pliable.

The *heart*, or chief organ of circulation, is a strong, hollow, muscular body, of a conical form, having its base above. In an adult person it is about five and-a-half inches in height, and about three and-a-half-inches in breadth at the base; its interior being divided into four different compartments, called auricles and ventricles. The heart is enclosed in a loose membraneous bag, called the *pericardium*,

which also lies upon it, like the envelope of the lungs; it serves to keep it in its position, as well as to secrete a fluid into itself for keeping its parts pliable.

The heart is situated behind the breast-bone, and between the two bags, or *pleura*, covering the two lungs; that space being called the *mediastinum*. It lies obliquely, with its base towards the spine and its point in front, a little towards the left side. It is kept in its position by means of the large vessels at its base, as well as by the bag which surrounds it, which is strongly attached to the diaphragm.

The large branch of the arteries, proceeding from the heart, is called the *aorta*. It rises from the left ventricle of the heart, and forms an arch above it, from which arch it sends off branches to supply the head and upper part of the body; after which it turns down behind the heart, and penetrating through the diaphagm, proceeds downwards, sending off branches in its course. About opposite the last lumbar-bone it separates into two large branches, called the *iliac arteries*, which go to supply the lower extremities with blood.

The thorax also contains the two large trunks of the veins, which are attached to the heart, called the upper and lower *vena cavæ*. Also a portion of the *thoracic duct*, or main trunk of the absorbents; likewise the *esophagus*, and parts of other vessels and organs passing up and down the body.

The organs contained in the ABDOMEN are the stomach, the small and large intestines, the liver, the pancreas, the spleen, the kidneys, the bladder, and parts of other vessels and organs.

The *stomach*, or chief organ of digestion, is a muscular bag about a foot long, and from four to five inches diameter

in its largest part, and is somewhat of the form of a bag-pipe. It is situated in the upper part of the abdomen, chiefly on the left side under the false ribs. The left and largest end is united to the esophagus, (the tube by which the food enters), its opening being called the *cardiac;* the opening of the right and small end, for the exit of the food, is called the pylorus.

The *small intestines* are small membranous tubes, about an inch in diameter, and about twenty-five feet in length. They are disposed in folds throughout the middle and lower portion of the abdomen, and are attached to the spine by means of a membrane called the *mesentery;* in which membrane the *mesenteric glands* are disposed.

The first twelve inches of the small intestines, proceeding from the pyloric end of the stomach, is called the *duodenum;* it is the portion in which the chyle begins to be formed. The remaining portion of the small intestines, in which the chyle is absorbed, is called the *jejunum* and the *ilium.*

The *large intestine,* the receptacle for the innutritious part of the food, is between five and six feet in length, and from an inch and a-half to two inches in diameter. It is united to the lower end of the small intestines, and is disposed in a large fold around them; its commencement is called the *cœcum,* and its termination the *rectum;* the intermediate part being called the *colon.*

The *liver,* or large gland which secretes the bile, and separates impurities from the blood, is situated in the upper portion of the abdomen, close to the diaphragm, principally on the right side, although a portion of it extends across to the left. It is of an irregular form, divided into two lobes; its length being from ten to twelve inches, its breadth from six to seven, and its weight from three to four pounds.

The *gall bladder*, for containing the bile, is on the under surface of the liver, and a small duct leads from it into the duodenum.

The *pancreas*, or the gland which secretes the pancreatic juice, is situated behind the stomach, close to the spine, its left end extending as far as the spleen. It is from six to seven inches long, and about two inches broad, it has also a small duct, which uniting with the duct from the gall bladder, leads into the duodenum.

The *spleen*, the functions of which are not clearly ascertained, is an irregular oval-shaped mass, about four inches long, and three inches broad. It is situated on the left side, behind the large end of the stomach.

The *kidneys* are the two glands by which the water is secreted. They are of the form of a scarlet bean, and, in the adult, are from four to five inches long, and about two and a-half inches broad. They are situated opposite the two last dorsal and two first lumber bones, one on each side of the spine; they are generally enveloped in a quantity of fat. Two excretory tubes, about the size of a quill, leading from the kidneys to the bladder, are called the ureters.

The *bladder*, or the receptacle of the water, is a membraneous bag situated in the cavity of the pelvis.

The interior of the abdomen, like that of the chest, is lined with a thin membrane, called the *peritoneum*, which is extended in a manner so as to envelope, secure, and protect the different organs contained therein. That portion of it which envelopes the small intestines is called the *mesentery;* that of the large intestine the *meso-colon;* and another portion of it in front, called the *omomentum;* between the folds of which a large quantity of fat is deposited, for protecting the abdominal organs from cold.

LESSON V.

THE ORGANS OF DIGESTION.

The various organs employed in the *digestion of our food* are the mouth, the teeth, the tongue, the salivary glands, the pharynx, the esophagus, the stomach, the liver, the pancreas, the small and large intestines, the lacteals, the mesenteric glands, and the thoracic duct.

The *mouth* is the cavity formed by the cheeks, the upper and lower jaws, the bony palate above, the soft palate behind, and the lips in front. The muscular parts are covered with a mucuous membrane, and supplied with a number of mucous glands for secreting a fluid to keep the parts soft.

The *teeth* are thirty-two in number,[1] sixteen in each jaw; different names being given to them according to their functions for cutting, tearing, and grinding the food. The teeth are firmly fixed in the jaws by their roots or fangs, and the cavities in which they are inserted, are formed of a spongy kind of bone so as to prevent any unpleasant vibrating or jarring sensation.

The teeth are composed of a dense kind of bone covered over with *enamel*, and have each a vertical cavity within filled with a pulpy substance. The bony and pulpy portions are amply supplied with blood vessels and nerves, which make

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[1] The 8 Incisors, 4 Canine, 8 small Molars, 12 large Molars.

them highly sensitive when exposed; but the hard enamelled surface, not being organized, serves to blunt their sensibility, as well as to prevent them from being quickly worn away.

The *tongue*, or principal organ of taste and speech, is made up of six muscles interlaced in each other; it is enveloped in a mucous membrane, and supported at its base by a small bone. It is well provided with blood vessels and nerves, the latter being spread out over its surface in those visible little papillæ, which give it the exquisite sense of taste. Four principal muscles are also provided for the different movements of the tongue.

The *salivary glands* are those organs by which the saliva is secreted for mixing with our food. They are six in number, three on each side of the mouth. They are easily excited by the thought of food, and frequently pour forth as much as half a pint of saliva during a meal.

The *pharynx* is the large cavity in the back of the mouth, which forms the upper portion of the esophagus or food pipe. There are six passages leading out of this cavity; two of them to the nose, two to the ears, one to the windpipe, itself constituting the other. The opening into the windpipe is called the *glottis*, and a little valve attached to the root of the tongue (called the *epiglottis*) is provided for closing up the glottis when we are swallowing our food. The passages into the back of the mouth are closed up in the act of swallowing by the soft palate, which in rising up to admit the passage of the food completely folds over them.

The *esophagus*, or tube which conveys the food to the stomach, being the lower portion of the pharynx, is situated behind the windpipe. It is made up of two layers of muscles, a membraneous envelope, and a mucous lining

membrane. The fibres in the external layer of muscle run lengthway, and those of the internal layer crossway round it, which arrangement gives it a contractile power to expand and close upon the morsel of food which, with the muscles above, force it downwards into the stomach.

The *stomach* is a strong muscular bag, something in the form of a bagpipe. It is capable of containing about three pints of food, although it is more capacious in those persons who live on a bulky innutritious kind of diet. It is situated in the upper portion of the abdomen, the large end being near the ribs on the left side, and its small end nearly opposite the pit of the stomach.

It is formed of two muscular and two membraneous coverings; the fibres in the one layer of muscle extending lengthways, and in the other crossway round it, as in the esophagus; an arrangement which gives it the power of contracting and extending in its length and breadth, producing what is called the *vermicular*, or worm-like motion.

The outside coating is a tough serous membrane, and the internal lining is a mucous membrane, disposed in loose folds or wrinkles, in which are contained the vessels that secrete the mucous fluid for keeping the parts moist; as well as those which secrete the *gastric juice*.

This juice is a transparent colourless fluid, slightly acid, possessing the property of dissolving every description of food.

The large end of the stomach, to which the esophagus is joined, is called the *cardia*, or cardiac opening; and the end attached to the duodenum, by which the food is expelled, is called the *pylorus* or pyloric end, or opening. The blood-vessels and nerves of the stomach form a complete net work of vessels, and abundantly supply it with blood and nervous energy.

The *liver* is a large gland, situated in the upper portion of the abdomen, its function being the secretion of the *bile*. This green bitter fluid is secreted by the liver from the venous blood, and is stored up in the *gall bladder* till wanted. All the veins of the digestive organs unite to form a large trunk called the *vena portæ*, which again dividing spreads its branches throughout the liver in its passage back to the heart, secreting the bile in its progress.

The *pancreas*, or sweet bread, is a gland, situated behind the stomach, by which is secreted a fluid, similar in appearance to the saliva of the mouth, called the *pancreatic juice*. This fluid slowly flowing into the duodenum, in conjunction with the bile, serves to separate the nutritious from the innutritious part of the food.

The *duodenum* is the first twelve inches of the small intestines, joined to the pyloric end of the stomach. It is the cavity in which the food begins to be converted into *chyle*. Like the stomach it is provided with two muscular coatings, an external envelope, and a loose mucous membraneous lining, arranged in folds so as to greatly enlarge the surface as well as to cause the food to pass slowly along. The ducts of the liver and pancreas run into it by a common opening.

The *small intestines*, of which the duodenum is the upper portion, are those small membraneous tubes which are arranged in folds, or convolutions, between the layers of the *mesentery;* the broad membrane which secures them to the back bone. In them the nutritious portion of the food is absorbed.

The *large intestines* are joined to, or continued from, the small ones in such a manner as to prevent any retrograde movement of their contents; they are about twice the size

of the small ones, and are disposed in a large fold around them. They form the large receptacle for containing the innutritious portion of the food.

The *lacteals* are countless little vessels spread out upon the inner surface of the small intestines; their functions being to absorb, or suck up, the chyle in its progress, and pass it onwards to the mesenteric glands.

The *mesenteric glands* are two sets of small glandular bodies, arranged between the folds of the mesentry. The branches of the lacteal vessels, after penetrating each set of these glands successively, pass the chyle onwards to the thoracic duct.

The *thoracic duct* is the small canal or receptacle into which the chyle is finally poured, and by which it is carried upwards and emptied into a vein on the left side leading to the heart.

LESSON VI.

THE PROCESS OF DIGESTION.

Digestion comprises those curious and complicated operations by which the food we take into our mouths is converted into *blood;* or nutriment for promoting the growth, and supplying the waste of our bodies.

The first process which the morsel of food undergoes is that of *mastication*, or chewing, while, at the same time, it is being *insalivated*, or moistened and intermixed with the saliva, the fluid which flows from the salivary glands; as also with the fluid which is poured out by the mucous glands of the mouth.

While this process is going on, the mouth is a *closed* cavity; formed in front by the lips, and behind by the soft palate, which drops down close to the tongue during mastication; but as soon as the morsel is prepared for swallowing it is gathered up by the tongue and muscles of the cheeks and, being passed backwards, the soft palate rises to admit of its passage into the pharynx.

The pharynx at the same time is extended and thrust forward to receive the morsel, and, having done so, its muscles instantly close upon it, and force it down the esophagus, by the muscular contractions of which it is forced onwards to the stomach.

The entrance of the wind-pipe being in front of the pharynx, the food has to pass over it in its passage; and, as death might result if the food happened to pass down this breathing tube, a beautiful contrivance is provided to guard against such a calamity.

This contrivance consists in the *epiglottis* (the little cartilaginous valve at the root of the tongue) turning down over the passage of the windpipe in the act of swallowing; the entrance itself at the same time spontaneously closing.

When the stomach is empty it is comparatively small, contracted, and motionless; its mucous lining hanging somewhat loosely, and presenting a soft velvet appearance of a light pink colour.

But no sooner has the morsel swallowed passed the cardiac opening of the stomach than the parts it comes in contact with become immediately excited. The pink colour changes to a deep red, by the flow of blood into the vessels, and the muscular fibre thus stimulated causes the muscular coatings of the stomach to *contract;* that is their fibrous cords, arranged the lengthway and crossway of the stomach, produce what is called the vermicular, or peristaltic motion; a motion slow at first, but increasing in activity as digestion proceeds.

At the same time the whole organ is thus stimulated, the folds of the mucous lining contract upon the food, the gastric juice begins to be secreted, and mixes with it, and continues to flow until the ordinary contents of the stomach are digested.

The food, after entering, revolves slowly round the stomach, from the large end to the small, and back again, till the mass is dissolved; the stomach successively grasping and breaking it up, and the contractions at the same time going on, cause every particle of the food to come in contact with the gastric juice.

The fragments of the food, being thus gradually softened, and finally converted into a soft, grayish mass, are detached from the harder, or indigested portions, and on reaching the

pyloric end of the stomach, are allowed to pass out by the muscles of that orifice relaxing. The same process takes place as every small quantity is digested, till the whole has passed out into the duodenum.

But though the pylorus readily relaxes so as to enable the *digested* portion to pass, it generally refuses passage to the *indigested* particles; and it is only after such indigested portion becomes troublesome to the stomach, that the pylorus, or gate-keeper as it is sometimes called, allows it to pass onwards.

But, whenever a larger quantity of food is taken into the stomach than usual, the gastric vessels are not at once prepared with gastric juice sufficient to digest it; in which case the food lies very uneasily in the stomach, till a sufficient quantity is secreted, occasioning what is called indigestion.

In like manner, if very indigestible food is taken, the gastric vessels have to secrete a stronger kind of juice, or to make it more acid than usual; and this circumstance also occasions the same distressing feeling. Indigestion may, however, proceed from many other causes.

Large quantities of *fluid* taken into the stomach, beyond what is necessary to moisten the food, pass off, for the most part, by another process than that of digestion; being *absorbed* by the capillary vessels of the stomach.

The food so far digested, or reduced to a rather liquid state, in the manner described, is called *chyme*, and the process called *chymification*.

The *duodenum*, into which the chyme passes, is provided with similar coatings as the stomach, but, as it is partly fixed in its place, its contractions are less active. The loose folds, or plaits, in the inner membrane cause the food to pass slowly along, as well as afford a greater space for containing

taining the secretory and other vessels. Some of these vessels secrete a fluid, of a solvent nature, which mixes with the food when it enters; and it is also into this organ that the *bile* and *pancreatic juices* are poured.

These two last fluids, flowing through their respective ducts, enter by a common duct into the duodenum about four inches from the stomach end; and drop by drop being mixed with the prepared chyme, effect on it an extraordinary change. They change what was previously chyme into two kinds of fluids, the one a milky, white, *nutritious* fluid called *chyle;* and the other a yellowish, thick, *innutritious* portion, both which substances pass down into the small intestines together. This part of the process of digestion is called *chylification.*

The juicy secretions from the pancreas and liver not only serve to effect this change, but they help to digest food which the stomach is sometimes obliged to cast out undigested. They also impart highly nutritious particles to the chyle, so as to bring it nearer to the nature of blood; and they also stimulate and promote the action of the intestines.

The *small intestines*, into which the chyle next enters, are also provided with muscular and membranous coatings which impart to them a *vermicular* motion; and this motion is accelerated by the upward and downward movements of the diaphragm in the process of breathing. Their membraneous lining, similar to that of the stomach, is abundantly supplied with blood-vessels, nerves, glands, and absorbents; and is also arranged so as to form loose folds, close to each other, which prevent their contents from passing too rapidly along, and greatly enlarge the surface.

The vessels employed for the absorption, or sucking up of the chyle, in order to pass it onwards to mix with the

blood, are called *lacteals.* These are small hair-sized vessels, distributed in countless numbers throughout the upper portions of the intestines, and becoming less numerous in the lower portions; they have their openings, or mouths, in the inner surface.

But, small as the lacteals are, they are each provided with blood-vessels, nerves, and internal valves, to prevent the chyle which they absorb from again returning into the intestines. These minute vessels, which absorb the chyle, unite to form branches, which, running along between the coats of the intestine, finally pass outwards, and convey their contents into the *mesenteric glands.*

These are small glands, enclosed between the folds of the mesentery, in the interior of which the chyle is still further purified and elaborated, and becomes more and more of the nature of blood. The chyle, after passing through two sets of mesenteric glands, is finally conveyed into the lower portion of the *thoracic duct.*

This duct, or tube, is about the size of a small quill; it extends from the loins upwards, close to the spine, as far as the junction of the *left* jugular and subclavian veins. Its interior is provided with valves, to prevent the retrograde passage of its contents.

The thoracic duct is the common receptacle of the *chyle* and *lymph;* the latter a fluid secreted by the lymphatic vessels.

The chyle, and lymph together, being conveyed up the thoracic duct, are emptied, drop by drop, into the venous blood in its progress to the heart.

The *innutritious* portion of the food, passing onwards through all the windings of the small intestines, is finally conveyed into the *large intestine;* the process of digestion being thus completed.

LESSON VII.

ORGANS OF CIRCULATION—THE HEART AND BLOOD-VESSELS.

The HEART is the forcing apparatus which impels the blood through the body. This it does by its compartments contracting and distending alternately; forcing out about two ounces of blood at each contraction, and contracting from sixty to eighty times every minute.

The heart is a strong muscular bag, of a conical form, situated in the lower portion of the chest, between the two lungs. It lies somewhat obliquely, with its base or broad part about the centre, leaning towards the spine, and its point forward, inclining a little to the left side.

It is kept in its position partly by the vessels belonging to it, and partly by the bag in which it is enclosed being strongly attached to the diaphragm, on which it rests.

This membraneous bag, called the *pericardium*, is much larger than the heart; admitting of its freedom of action, while at the same time it secures it in its place, and protects it from the injury it might otherwise sustain by the varied movements of the body. A fluid is also secreted in the interior of this bag for preventing the ill effects of friction.

The interior of the heart is divided into four compartments; the two upper ones called the right and left *auricles*, and the two lower ones the right and left *ventricles*. In the division between the compartments on the right side

of the heart, is an opening, with a curiously-constructed valve called the *tricuspid valve,* serving as a flood-gate to admit of the blood flowing down in the proper direction, but effectually preventing its return. There is also a similar aperture in the division on the left side of the heart, with a valve for the same purpose, called the *mitral valve.* The mouths of the two principal vessels of the heart[1] are also provided with what are called *semi-lunar valves.*

The vessels for conveying the pure, or *arterial blood,* from the heart, to afford nourishment to all parts of the body, are called ARTERIES. The vessels that bring back the impure, or *venous blood,* from different parts of the body to the heart, are called VEINS.

There are also a set of vessels attached to the heart for conveying the blood to and from the lungs. The large vessel which conveys the impure blood from the right ventricle of the heart to the lungs to be purified, is called the *pulmonary artery;* it having two branches, one leading into each lung. When the blood is purified in the lungs, it is conveyed back to the left *auricle* of the heart by means of the *four pulmonary veins;* two proceeding from each lung.

The main trunk, or chief branch, of the arteries is called the AORTA. This large tube has its opening in the left ventricle, from which compartment it rises upwards, forming an arch over the top of the heart; then passing behind it, it proceeds downwards, sending off branches in its course, till it finally separates into two large trunks, one going into each thigh.

From the arch of the aorta there are sent out two[2] large

[1] The Aorta, and Pulmonary artery.

[2] The Carotid arteries.

branches to supply the head and neck with blood; two[3] others to supply the upper portion of the trunk, the arms, fore-arms, and hands; and two[4] others to supply the heart itself.

As the aorta proceeds downwards through the thorax it sends off three[5] branches from each side to supply the internal muscles, and vessels and organs contained in it; and in like manner, in its course through the abdomen, it sends off nine[6] branches to supply the various organs and parts belonging to this cavity.

The division of the aorta, into the two[7] large branches of the lower extremities, takes place opposite the fourth lumbar bone; from which divisions a number of smaller branches are sent off to supply the lower portion of the trunk.

The large or main[8] branches in their course through the thighs send off minor branches, and when they reach below the knees each of them separate into three[9] branches, which go to supply the legs, feet,[10] and toes, with blood.

From these large divisions and branches of the arteries

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[3] The Subclavian and Axillary arteries; these become the Brachial in the arms, the Radial and Ulnar in the fore-arms, and the Palmar arteries in the Hand.

[4] The Coronary arteries.

[5] The Thoracic branches are the Bronchial, the Esophageal, and Intercostal arteries.

[6] The Abdominal branches are the Phrenic, Cœliac, Superior Mesentric, Spermatic, Inferior Mesentric, Supra-Renal, Renal, Lumbar, and Sacral Median arteries.

[7] The Iliac arteries, becoming—

[8] The Femoral and Popliteal in the thighs,

[9] The Front and Back Tibial, and Peroneal in the legs, and

[10] The Plantar arteries in the feet.

other smaller ones proceed; from them again still smaller and smaller ones, like the branches of a tree; till at last they terminate in the minutest branches, called the *arterial capillaries*, which are distributed throughout the muscles and organs of the body in a complete network of vessels.

In the arterial capillaries the blood parts with its nourishing properties, and begins to course its way back to the heart, gathering up in its way all the waste and noxious particles it meets with.

It comes back to the heart, however, in an inverse order to that by which it passed out. It first enters the extreme ends of the veins, which are called the *venous capillaries;* and these, in its way back, convey it into larger and larger veins; till at last it is emptied, by two large venous trunks, into the right auricle of the heart.

These two large trunks are called the SUPERIOR AND INFERIOR VENA CAVÆ; the former bringing back the blood from the upper part of the body, and the latter from the lower; excepting that the veins belonging to the different organs contained *in the abdomen* pour their contents into one large trunk, called the *vena portæ*, which, again dividing into branches, distributes the blood throughout the liver in its way back to the heart.

The chief branches of the *veins* are distributed through the body in a similar manner to the arteries; the greater number of them side by side with the arteries, and many of them enclosed in the same sheath. The veins are, however, larger and more numerous than the arteries, there being in the legs and arms generally two veins to one artery.

The arteries which convey the blood to the brain, being the two *internal carotid* and two *vertebral* branches, are tortuous or winding in their course; as if to check the

sudden rush of blood to so delicate an organ. The vessels which bring back the venous blood from the brain are the two internal branches of the *jugular* veins.

Arteries are composed of three coats, one over the other; the middle one of a fibrous nature, giving great elasticity to the tube, and thus equalizing the flow of blood. The veins are also composed of three coats, but they are much thinner than those of the arteries. The supply of blood for their nourishment is derived from arteries in their vicinity, but is distributed throughout their coats by means of their own minute blood-vessels, called the *vasa vasorum.*

As the blood in the veins has for the most part to flow upwards, there is provision in their interior to prevent the upward current from retrogressing. This consists in the internal membrane being arranged in semi-lunar folds, so as to form little valves at different distances throughout the veins; these valves allowing the blood to flow towards the heart, but preventing its return.

LESSON VIII.

THE BLOOD—ITS CIRCULATION.

The Blood is the vital fluid out of which all the different parts of our bodies are formed; whether they be the solid bone, muscle, brain or membrane; or the fluid milk, bile, or gastric juice.

Pure blood is also the sustaining principle of life; for when the heart ceases to send its vital stream for building up and nourishing the different parts of our bodies, for stimulating its various organs, and for taking away waste and noxious particles, our senses immediately fail us, our muscles relax, and the whole of our delicate mechanism speedily stands still.

The quantity of blood in a healthy adult person is estimated to be about twenty-eight pounds, which is propelled by the heart so as to complete the circulation of the body in about two minutes and a half. From which rapidity of circulation it has been calculated that about an hogshead of blood must pass through the heart every hour.

Seen by the unassisted eye, *arterial* or pure blood is of a bright scarlet colour; while *venous*, or impure blood is of a dark purple; but when examined by the aid of a microscope, circulating in the living vessels, it is found to consist of minute red particles floating in a colourless fluid.

Those particles in the human species are in the form of flattened globules, of equal sizes, and about the three thousandth part of an inch in diameter. In some species of animals, however, the globules oft he blood are elliptical.

The colourless fluid, called the *linguor sanguinis*, holds, either in suspension or solution, a very important element of nutrition, namely the *fibrin* of the blood; which separates from the watery parts when coagulation takes place.

By *coagulation* is meant that property which the blood of a healthy person has of clotting, when it has been removed from a vein or artery. That is of separating into two distinct parts, the one a light straw-coloured liquid called the *serum* of the blood, and the other part red and solid called the clot; the latter being a net-work of the fibrous particles of the blood having the red globules contained in the fibrous meshes.

This coagulating property of the blood seems to depend on the *fibrine* contained in it, and on that the health of the body; for blood deprived of its fibrine will not pass into the minute capillary vessels. This property of coagulating is also a beautiful provision of nature for stopping the effusion of blood in cases of cuts and wounds, as well as for healing them; for the clot of blood on the edges of a wound speedily becomes full of minute organized vessels, which serve to re-unite and heal the wounded part.

When the blood is analysed, it is found to contain about twenty-five different substances, animal and mineral; but the *fibrine* of the blood seems to be the chief element for nourishing and renewing the different organs of the body.

The organs of circulation having been described, the manner in which it is circulated or distributed throughout the body will now be understood.

Supposing the current of blood to have imparted its nutritive properties to the different tissues of the body, and to have coursed its way back to the heart to be purified, it is poured by the two chief branches of the veins, called the

superior and *inferior vena cavæ*, into the *right auricle* of the heart.

This impure or dark venous blood stimulating the right auricle causes it to contract upon it, or to force it down through the tricuspid valve into the lower compartment, called the *right ventricle;* which also contracting, the valve at the same time preventing the blood from returning, forces it up through the *pulmonary artery*, by the two branches of which it is conveyed out into the lungs to be purified.

The blood, having been thus conveyed to the lungs, is distributed into smaller and smaller branches of the arteries until at last it enters the extreme branches, called *arterial capillaries*; which are spread out over the air vesicles of the lungs so as to form a complete net work of vessels.

The air having been conveyed into the lungs, by the minute branches of the wind-pipe, finally enters the interior of the air vesicles, and its oxygen penetrating through the delicate membrane of which they are composed comes in contact with the blood. The purification of the blood being effected by the oxygen of the air and the carbon contained in the blood having a mutual affinity for each other.

The blood being thus purified, is conveyed back again to the heart by another set of vessels, called the *four pulmonary veins;* the blood passing from the arterial into the venous capillaries, which are also spread out over the surface of the air vesicles, is by them conveyed into larger and larger branches until it is finally conveyed by the four pulmonary veins into the *left auricle of the heart.*

When it is conveyed into the left auricle, that compartment immediately contracts and forces it down through the mitral valve into the lower compartment, called *the left ventricle;* which also contracting, and the valve at the same

time preventing the return of the blood, forces it up in the *aorta*, or chief branch of the arteries.

The blood, being sent into the aorta, with a force capable of sustaining a column of blood eight feet in height, is conveyed into its different branches, and by them into smaller and smaller arteries, until it is finally distributed by the *capillary arteries* into every tissue of the body.

It is in the capillary arteries that the process of *nutrition*, or the building up and repairing of the different parts of the body, seems to begin; the blood depositing in its course fibrous particles to nourish the muscles, bony materials for the bones, nervous matter for the brain, and in like manner materials for nourishing all parts of the body; the various particles seeming to possess an attractive power for the part or substance analagous to their own nature.

The blood by this process of nutrition parts with a portion of its sustaining and nutritive qualities, as well as with the oxygen it acquired in the lungs; and acquiring in return the waste and decaying particles of the different tissues, and the carbon consequent on that waste, becomes *venous*, or impure; being charged with carbonaceous and noxious materials injurious to the system.

In coursing its way back to the heart it passes from the arterial into the *venous capillaries*, and by these is conveyed into larger and larger veins until it is finally brought back again to the heart by the two *vena cavæ;* there to be again circulated in the manner described.

From the description given it will be seen, that, while the *arteries* convey pure blood and the *veins* impure in the general circulation of the body, *in the lungs this process is reversed;* the arteries in them conveying *impure* blood, and the veins *pure*.

LESSON IX.

THE ORGANS OF RESPIRATION.—RESPIRATION.

The LUNGS are the chief organs of respiration, or breathing; by which process the air is brought in contact with the blood, for the purpose of purifying or changing it from dark *venous*, into *arterial*, or bright red blood; as well as for combining with certain elements in the blood in order to develope the *animal heat* necessary for keeping up the warmth of our bodies.

The lungs are two spongy bodies, somewhat conical in form, situated one on each side of the chest, with the heart between them; they being kept in their position by means of the *pleura*, the membrane in which they are enclosed.

They extend in height from the first rib to the diaphragm, and, together with the heart, nearly fill up the cavity of the chest. The right lung is the larger, and is divided into three lobes, the left lung having but two.

The substance of the lungs consists of bronchial tubes, air-cells, blood-vessels, nerves, and glands; the whole connected together by a net-work of fibrous tissue. Nutrition is afforded to them by means of arterial branches leading from the aorta; two of these going into each lung.

The organ by which the air is conveyed to the lungs is the *trachea*, or wind-pipe; which, on entering the chest, separates into two branches, called the right and left *bronchus*, one going into each lung. In the lungs these branches divide into two branches, and each of these into smaller and

smaller ones; till at last they terminate in clusters of minute membranous cells, called *air vesicles.*

These air vesicles are said to be about the hundredth part of an inch in diameter, and so numerous that were the whole of their membraneous linings spread out, they would occupy a surface equal to *thirty times that of the body.*

The trachea, and its larger branches, are always kept open for the admission of air by means of little rings of cartilage; and the smaller branches by means of a fibrous elastic kind of membrane. This is an important provision of nature; for, were the air shut out from the lungs for the space of only three or four minutes, death would be the result.

Another beautiful arrangement is seen in connection with this. The tube for the admission of food into the stomach is attached to the back of the trachea, and if the rings of cartilage extended round the tube, they might so press upon the food-pipe as to interfere with the passage of its contents; this, however, is effectually guarded against by the rings, in this part, only going about *two-thirds* round.

The vessel for conveying the venous blood from the right ventricle of the heart to the lungs is the *pulmonary artery;* one of its branches entering each lung. In the lungs these branches divide into smaller and smaller branches, accompanying the bronchial tubes throughout the lungs; till at last their capillary extremities are spread out in a minute net-work over the surface of the air vesicles.

The vessels for bringing back the purified blood from the lungs to the left auricle of the heart, are the *four pulmonary veins;* the capillary extremities of which are continuous with those of the pulmonary arteries of the lungs.

The other organs of respiration, *which produce the movements of the lungs,* are the ribs and muscles on each side of

the chest, and the diaphragm, or the muscular partition which separates the chest from the abdomen.

The organs having been described, the following is the manner in which the *air* is taken into and expelled from the lungs; by which element the purification of the blood, and the development of animal heat, are effected.

The cavity of the chest is enlarged, *for a fresh inspiration of air*, by the ribs being drawn upwards and extended forwards through the contractions of the muscles belonging to them; while, at the same time, the contraction of the diaphragm forces it downwards on the abdomen. The lungs at the same moment expanding by their elasticity, and the air rushing into them, they being no longer compressed, every part of them is filled.

At the same moment that the vesicles of the lungs are thus filled with air, a stream of dark venous blood is distributed over their surface by the minute branches of the pulmonary artery. The oxygen of the air contained in the vesicles, penetrating through the delicate membrane of which they are composed, comes in contact with the blood contained in the arterial capillaries which are spread over their surface; and instantly changes it from a dark purple to a bright scarlet.

The air is *expired*, or expelled, from the lungs, chiefly by the relaxation of the muscles of the chest enabling the ribs to descend and fall in, while the contraction of the abdominal muscles helps to pull them downwards, at the same time causing the contents of the abdomen to push the diaphragm upwards. The cavity being thus diminished, and the lungs compressed, a portion of air is forced out of the air vesicles, while, at the same moment, the stream of purified blood is sent back to the left auricle of the heart.

The change effected by the air on the blood is by a chemical process, depending on the mutual affinity of two elements.

The air we breathe is composed of four parts of nitrogen and one part of oxygen, with a minute portion of vapour and carbonic acid. When this compound enters the air-vesicles of the lungs, the oxygen of the air, having an affinity for the carbon in the blood, penetrates *inwards* through the lining of the air-vesicles, and, uniting with the blood, changes its carbon into carbonic acid, which penetrating *outwards* through the coats of the vesicles, is expired from the lungs.

The blood thus freed from carbon, and charged with oxygen, at every inspiration of the lungs is conveyed onwards by the blood-vessels into every tissue of the body; and by its active combination with the waste and carbonaceous parts of the blood *generates heat* throughout the system.

As the lungs differ in size in different individuals, so does the quantity of air that they are capable of containing; but the lungs of an adult man are estimated to contain from ten to twelve pints. The quantity taken into the lungs at every inspiration also varies, according to the effort made; but in an ordinary inspiration, without exertion, it is supposed to be about *a pint of air.*

The heart is said to contract *four times* while we breathe *once;* and, as an adult person in good health breathes about eighteen times in a minute, the quantity of air conveyed to the lungs daily is supposed to be about *fifty-seven hogsheads.*

The quantity of carbonic acid expelled from the lungs is somewhat in proportion to the air inspired; the quantity expelled daily, if concentrated, is supposed to amount to from *seven to fourteen ounces of solid carbon,* in addition to

a large amount of moisture, and other noxious matters, which are thrown off by the process of breathing.

From the large amount of air required for the wants of the system, and from the constant deterioration of the atmosphere around us, we must perceive the necessity for living in a pure air, and for well ventilating our apartments, in order to realize all the enjoyments of health.

LESSON X.

NUTRITION, &c.

Digestion and *Circulation* are, as described, two great means of preparing and purifying the blood, so as to afford NUTRITION to the body—*Secretion* is a further means of separating and elaborating from the blood various materials necessary for the wants of the system—*Absorption* is the process by which such materials are gathered up and taken to the parts required—and *Excretion* that by which waste and pernicious particles are thrown out of the body.

In the young the different tissues, or minute parts of different organs, have to be enlarged; and this constitutes what is called *growth*. But in addition to this there is a continual *waste* of the different particles of the body, both in young and old; the amount of such waste being principally dependant on the health of the person, and the use and exercise of his different powers.

The *health* again, seeming to depend upon the purity of the blood, and the rapid changes that are effected in the different tissues by exercise; both mentally and bodily. The blood, by such exercise, being impelled more rapidly through the system, not only more speedily removes waste and decaying particles from the tissues in its passage, but, by a greater quantity of it vigorously flowing through the lungs, it receives a larger supply of oxygen to stimulate and nourish; thus imparting to mind and body the warm glow, the buoyant feeling, and mental pleasure, which we call *health*.

The blood when pure contains all the elements necessary

for the building up and nourishing of bone, muscle, tendon, membrane, nerve, and every other part of the body; and NUTRITION is that great and subtile operation of nature by which those different elements are deposited on the particular parts required, and there only.

The current of blood, sent by the force of the heart into the capillaries, which pervade every part of the body, performs the work of nutrition while in those vessels; but how that work is carried on is not so clearly ascertained.

The process has, however, been thought by some to be analogous to that which takes place in the air vesicles of the lungs; where a mutual exchange of different substances takes place through the delicate membrane of which they are composed.

As therefore the membraneous coverings of the arterial capillaries are still more delicate in their texture than those of the air vesicles, it is supposed that the affinity between the elements, within and without the capillaries, may cause the oxygen and nutritious part of the blood *to pass out* through their membraneous coverings, and to be deposited on the part required; while at the same time the carbon and waste particles *are passed inwards*, through the sides of the capillaries, and thus conveyed into the current of blood; *animal heat* being generated by the process.

But, by whatever means the deposition or change may be effected, it seems clear that the arterial current in its circulation through the body deposits bony particles on bone, muscle on muscle, and in like manner on every substance of the body the material analogous to its nature. But whether this is effected by an attractive property between the elements, or by the agency of the minute nervous filaments which are numerously spread out over the surface

of the capillaries, is as yet one of the undiscovered operations of nature.

It is, however, not merely the change, but the peculiar arrangement of the different particles that excites admiration; the new nutritious elements being deposited according to the texture of the various parts which they supply; forming the dense bone which supports—the contractile fibre which moves—the nerve which stimulates—and the hair of the head destitute of feeling.

Nutrition having been effected, or the blood having parted with some of its life-sustaining constituents while flowing in the *arterial capillaries*, this fluid gradually loses its bright scarlet colour; and while coursing its way back to the heart in the venous capillaries, acquires the peculiar purple hue of venous blood.

The name, however, of *capillary* or hair-sized vessels, conveys but a very imperfect idea of their extreme minuteness; for in comparing a hair with the smallness of some of them, it is like comparing the trunk of a tree to its minute branches.

Such then is the extreme minuteness of the capillary vessels, that, what might be thought, a very trifling cause, will impede the circulation of the blood within them; and thus not only check nutrition, but prevent noxious matters in the blood from being excreted.

Externally they are greatly affected by heat and cold, the former increasing and the latter impeding their circulation; and the more so when the body is exposed to any sudden chill. *Internally* their circulation is impeded by any alteration in the character of the blood; whether arising from injurious substances taken into the body, or by noxious impurities not being removed out of it.

LESSON XI.

SECRETION.

SECRETION is that process by which various substances are secreted, or separated from the blood, (but not for nutriment); some of them to serve a particular purpose *within the body*, as the saliva, gastric-juice, bile, &c.; and some of them noxious ingredients *to be removed out of it*, as the secretions of the skin, lungs, kidneys, &c.

The materials, or elements, of which all the different secretions of the body are formed are contained in the blood; and secretion is the process by which particular substances are prepared, each by its peculiar organ, and by some unknown affinity, or agency, equally mysterious as that by which nutrition is effected.

As the substances secreted are various, so are also the different organs by which they are formed; some of them being very simple in their structure, and others exceedingly complicated; some of them distributed throughout the body, as the follicles and glands of the skin, and others confined to particular localities, as the liver, pancreas, kidneys, &c.

The simplest form of a secretory organ is seen in the different *membranes* of the body.

That which is called *serous membrane*, such as lines the cavity of the chest and abdomen, and envelopes the organs contained in them, secretes or transudes a serous kind of fluid, by means of the *capillary vessels* which course through them.

That which is called *mucous membrane*, such as lines the mouth, stomach, lungs, and other internal passages, secretes a mucous fluid, by means of minute secretory *cells* or *fol-*

licles; over the surface of which are spread out capillary vessels and nerves, which separate from the blood a mucous fluid, and pass it into the interior of the cells; from whence it is poured out when required.

A cluster, or aggregation, of single cells or follicles, (such as those which secrete the oily fluid for keeping the skin soft,) are called *glands;* those of the skin being of the simplest form. Over the surface of each of those minute follicles are spread out capillary vessels and nerves, by the agency of which the oily fluid is secreted from the blood, which being passed through the membranous covering of the follicle, is poured out on the surface of the skin as required.

A more complicated kind of gland, such as the parotid glands, the pancreas, and liver, is made up of myriads of such small secretory vessels; each vessel having minute branches of arteries, veins, and nerves, spread out over its surface; the whole being connected together, and enclosed in a membrane, and provided with vessels for containing or conveying the secretion.

The form of the secretory cells varies in different kinds of glands; in some they are elongated into bag-like bodies, called follicles, and in others they are still more elongated, forming long tubular vesicles.

The arrangement of those cells also varies in different glands; in some they are united so as to form a tree-like appearance, the cells arranged so as to pour their contents into branching tubes, and these again into a common excretory trunk; an arrangement which is seen in the salivary glands and the liver. In some glands the tubular-shaped vesicles are curiously convoluted, a beautiful arrangement of which is seen in the kidneys.

Taking, therefore, into account the extreme minuteness and vast numbers of these membranous cells, and more especially in the large glands of the body, we see that they make up a secretory surface of incalculable extent.

But curious and wonderful as is the structure of the whole glandular system, its functions are still more so; for the mode by which the same vital current secretes so many varied productions has hitherto eluded all investigation.

It is found, however, that the nervous system has great power over the secretions, through the medium of the nervous filaments, which are spread out in vast numbers over the capillaries which cover each secretory cell. Thus the thought even of food will stimulate the flow of the saliva, bad news will check the secretion of the gastric vessels, and the mother's milk will flow at the sight, or even the thought, of her child.

It is found, also, that the different organs of secretion throughout the body strongly sympathize with one another, although their functions may be dissimilar. Thus, if anything interferes with the functions of the lungs, so as to prevent the due secretion of carbonic acid from the blood, the liver immediately sympathizes and secretes, and passes out through the bowels a larger amount of carbonaceous impurities.

In like manner, if the secretory functions of the skin are affected, so as to prevent the waste fluids and noxious ingredients from passing outwards through its pores, the kidneys or bowels at once perform additional labour to get rid of them.

This sympathy between different organs, causing some of them to perform double duty, will account for their frequent derangement; they being often tasked beyond their powers.

LESSON XII.

ABSORPTION, &c.

Absorption is that process by which different substances, secreted within the body, are gathered up by various organs and conveyed to the parts required; as well as the process by which various substances are externally absorbed, or taken, into the circulation of the blood.

The chief *organs* of absorption are the lacteal vessels, with their mesenteric glands, the lymphatic vessels and glands, the blood-vessels, and different membranes of the body.

The organs for absorbing the nutritious product of digestion are the *lacteal vessels* and *mesenteric glands*. The lacteals are very minute vessels, having their mouths in the interior of the small intestines, by which they absorb or suck up the *chyle*. The mesenteric glands are small roundish bodies, of various sizes, situated in the mesentery, to which the chyle is conveyed by the lacteals, and in which it is purified and elaborated, so as to become more of the nature of blood, previously to its being conveyed into the thoracic duct.

The organs for absorbing, or gathering up, such waste or superfluous particles of the body, as it may be necessary to re-introduce into the current of the blood, are the *lymphatic vessels* and *glands*.

The *lymphatic vessels* are minute transparent tubes, traversing most parts of the body, some of them near the

surface and others deep seated in the muscles and other organs. They do not branch out into smaller and smaller vessels like the arteries, but maintain the same size throughout; varying however in differents parts of the body. They are provided with little valves in their interior, like the veins and lacteals, and seem to possess a contractile power to propel their contents onwards. Like the lacteals they also pass through small roundish bodies in their course, called the *lymphatic glands;* and they likewise empty their contents by different branches into the thoracic duct.

The substance absorbed by the lymphatic vessels is a thickish transparent kind of fluid, called *lymph;* highly nutritious in its nature, and, in its progress through the lymphatic glands, it becomes more and more of the nature of blood as it approximates towards the thoracic duct; where it mixes with the elaborated chyle.

The disintegrated, and waste, particles of the body are absorbed by the lymphatic vessels before the new nutritious particles are deposited by the arterial capillaries; thus forming as it were the moulds of the different tissues.

It is supposed that during *the growth* of the body a larger portion of the nutritious particles are deposited, in all its tissues, than are taken up by the absorbent vessels. That when the body is *full grown*, and in a state of health, the new nutritious particles are about equal to the worn out portions absorbed. That in sickness, or *when the body is wasting*, a greater portion of the waste particles are absorbed then are replaced by new nutritious particles; the different functions being weakened and not able to provide them.

But in addition to these *special organs of the absorbent system*, there are other parts of the body more or less absorbent in their nature.

The *skin* is proved to be absorbent, as various medical substances are often passed through it, especially by friction; and when its cuticle is removed they are found to be still more rapidly absorbed.

It is by this absorbent function of the skin that vaccination and innoculation are effected—that putrid and poisonous matter is rapidly absorbed through the slightest wound—that nutritious substances given in baths are often absorbed through the skin, sufficient to keep patients alive when food cannot be otherwise administered—and that thirst is often alleviated at sea, by persons dipping their clothes in salt water.

The *lungs* are also highly absorbent, as noxious fumes and impurities in the atmosphere are instantaneously introduced into the current of blood, through the delicate membrane of the air vesicles. It has been often proved that air, contaminated with putrid and decaying vegetable and animal substances, breathed into the lungs, as well as when these are otherwise absorbed into the system, generates fevers, agues, dysenteries, and other virulent diseases.

The *blood vessels* are proved to be absorbent, as poisonous substances, dropped on their surface, will contaminate the mass of blood more readily than if taken into the stomach and bowels; as the mucous fluid in the latter organs somewhat delays the power of absorption. It has also been shown, by experiment, that fevers and other disorders, more or less virulent, are engendered by minute portions of putrid matter being introduced into the circulation of the blood.

Different *membranes* of the body are also absorbent, as is shown in cases where fluid matters, having found their way into the large cavities of the body, have been rapidly absorbed.

Such being the functions of the absorbent system, they teach us to avoid all damp and badly drained localities, to remove all noxious and decaying matters from our dwellings, and in all cases of wounds, or abrasions of the skin, to protect the part by a proper covering.

EXCRETION.

Excretion may be defined to be that function by which different organs of the body discharge waste and noxious materials. The functions of different excretory organs have already been generally described in the ELEMENTARY SERIES.

LESSON XIII.

THE BRAIN AND NERVOUS SYSTEM.

The BRAIN, and NERVES connected with it, are the especial organs of our *sensations, thoughts,* and *movements.* The nerves are generally distinguished as those of *organic* and of *animal* life.

They may, however, be conjointly classified into *three* divisions; namely, those by which all impressions are made on the brain (through the medium of the senses) called *the nerves of sensation*;—those by which the brain conveys its desires, and controls different movements of the body, called *the nerves of motion*;—and those which stimulate and control the functions of different organs within the body, called *the sympathetic, or organic, nerves.*

What is called *the nervous system,* comprises the brain—the spinal cord—nine pair of nerves proceeding from the brain, and portion of the spinal cord *within* the skull—thirty-one pair proceeding from the spinal cord *without* the skull—and the great sympathetic nerves; consisting of a series of nervous branches and ganglia, extending from the base of the skull downwards on each side of the back-bone.

The BRAIN may be considered the great centre of the nervous system; and the nerves leading to and from it as the instruments of its communications, desires, and resolves. It is an oval-shaped medullary body, filling up the cavity of the skull; which it enlarges and modifies according to its growth and development.

Being of a soft nature it is secured in its position by means of a tough membrane, called the *dura mater*; which also serves to prevent one portion of it from pressing upon another. A fold of this membrane firmly attached to the skull, from back to front, forms a partition dividing the brain into what are called *the right and left hemispheres*; a similar fold, extended across the back of the skull, also separates the *upper* from the *lower* part of the brain.

The upper, and larger, portion of the brain is called the *cerebrum*; the upper surface of which is curiously disposed in winding tubular folds, called the convolutions of the brain, which, by their folds and spaces between; afford a greater amount of surface. The lower surface of it is divided into what are called the front, back, and middle lobes.

The lower and back portion of the brain is called the *cerebellum*; it is about one-eighth the size of the upper portion. It is also divided into two hemispheres, and into several small lobes, but the folds on its surface are much smaller than those on the upper portion of the brain, and are arranged in semi-circular curves, or lamina.

At the base of the brain, and connected with the two portions described, is a short and expanded portion of the spinal cord, called the *medulla oblongata*; different names being given to prominent portions of it.

Within the brain are four cavities, having communication with each other, called the *ventricles* of the brain; they are lined with a serous membrane, which secretes a fluid for moistening their interior.

On examining the internal structure of the brain it presents the appearance of a soft, white, fibrous mass, united at the base, and disposed in numerous folds and convolutions connected together throughout the brain; over the surface

and between the folds of which is spread out a thin layer of a greyish granular kind of matter; the white being called the *medullary*, and the grey the *cineritious* substance of the brain.

Beneath the dura mater, already described, are two other membranes covering the brain; one as fine as a spider's web spread out over its surface, called the *arachnoid*, and the other a thin membrane abounding in blood-vessels, penetrating deeply between the convolutions, called the *pia mater*.

The SPINAL CORD, or main trunk of the nervous system, is a collection of nerves and nervous matter enclosed in the cavity of the back-bone. It is connected with the brain above, and extends as far downwards as the second lumbar bone.

Its form is that of a flattened cylinder; its size about half an inch in diameter, somewhat enlarged at the lower part of the neck and loins, where the nerves of the extremities have their origin.

It is enveloped in three membranes similar to those of the brain, which are continuous with them; and is guarded from pressure by the fluid secretions of the membranes, and by being surrounded with a soft fatty substance.

It is partially divided, by a front and back fissure, into two equal parts, and each of these is again sub-divided into three divisions, so that the whole may be said to be made up of six columns; the front and side columns being *nerves of motion*, and the back columns *nerves of sensation*.

The *interior* of the spinal cord contains a layer of cineritious matter, similar to what is found on the *outside* of the brain.

The NINE PAIRS OF, what are called, CRANIAL NERVES,

have their origin *within* the skull; the first pair proceeding from the brain itself, and the other eight from the upper and expanded portion of the spinal cord connected with the brain.

The first pair, or the *olfactory* nerves, are the nerves of smell; the minute branches of which are spread out over the lining membrane of the nose.

The second pair, or the *optic* nerves, are the nerves of sight; their branches being spread out on the innermost membrane of the eye-ball, called the *retina.*

The third pair, or the *common motor* nerves, are nerves supplying the chief muscles that produce the movements of the eyes.

The fourth pair, or the *trochleares,* are two small motor nerves, supplying the upper muscles that roll the eyes in their sockets.

The fifth pair, or the *trifacial* nerves, are the two great sensation nerves of the head and face; each of them sending off three large branches to different parts.

The sixth pair, or the *abducentes,* are two small motor nerves, supplying the external rectus muscles of the eyes.

The seventh pair, or the *auditory* nerves, consist each of two portions; one distributed over the membrane in the interior of the ear, being the nerve of hearing; and the other leading to the side of the head and face, being a nerve of motion.

The eighth pair, or the *pneumo-gastric* nerves, may each be considered as three separate nerves, as they each rise from three roots. They are both sensitive and motor in their functions; they have branches distributed to the root of the tongue, the pharynx, larynx, lungs, heart, stomach, and some of the muscles of the neck.

The ninth pair, or the *lingual* nerves, are the principal nerves for producing the different movements of the tongue.

The THIRTY-ONE PAIR OF SPINAL NERVES branch out on each side of the spinal cord; each nerve having a portion of its roots proceeding from the back part of the cord, and another portion from the front part.

The back, or *sensitive*, roots, in passing from the spinal cord, unite and form a small knot, or ganglia; but the front, or *motor* roots do not, but merely unite; the two branches formed by these roots, as they pass through the openings of the vertebræ, unite and form the body of the nerve.

The nerves so formed separate again, on the outside of the ganglia, into two branches; one going to supply the back part of the trunk, and the other the front part and extremities.

The spinal nerves are known as the *eight* cervical, *twelve* dorsal, *five* lumbar, and *six* sacral nerves.

From the upper and lower portions of the spinal cord, where the nerves branch off to supply the extremities, a number of them unite and branch into each other, so as to form a kind of net-work, called a *plexus* of nerves.

The four lower cervical and first of the dorsal nerves unite to form what is called the *brachial* plexus; from which, among other important branches, proceed the nerves for supplying the upper extremities; distinguished as the *median*, *radial*, and *ulnar* nerves.

The dorsal nerves, as they proceed from the spinal cord, separate each into two branches, one going to supply the skin and muscles of the back, and the other the intercostal muscles.

The lumbar and sacral nerves also unite to form plexuses, from which, among other branches, proceed the nerves for

supplying the lower extremities. The chief branch formed by this union is the great *ischiatic* nerve, the largest in the body; it separates about midway down the thigh into two branches, called the *tibial* and *peroneal* nerves.

The SYMPATHETIC SYSTEM may be considered as a separate set of nerves, belonging to what is called our organic life; yet having a communication with the other nerves of the body. It consists of a series of ganglia and branches, forming a kind of nervous chain, down each side of the spinal cord; and connected with a number of branches and ganglia supplying the various organs within the body.

When the structure of the nervous system is microscopically examined, it is found that the *grey* or *cineritious* substance consists of myriads of minute cells and granules of different sizes, held together by a minute net-work of blood-vessels.

That the white fibrous or *medullary* substance is made up of numerous bundles of exceedingly minute tubes, containing a colourless kind of fluid; each bundle enclosed in a thin membrane, and the whole held together by means of a delicate tissue.

These tubes can be traced in the fibrous substance of the brain; some of them diverging from the upper portion of the spinal cord towards the convolutions, and some proceeding from the surface of the brain, and converging to the substance of the spinal cord.

The nervous tubes seem to pursue an uninterrupted course from their origin to their termination, which is generally in the form of minute loops.

LESSON XIV.

THE ORGANS OF SENSE.

The ORGANS OF SENSE are those curiously formed instruments, connected with the nervous system, through which all our knowledge of external objects is conveyed to the brain.

We have five different organs of sense; namely, those of *hearing*, *seeing*, *smelling*, *tasting*, and *touching;* the first four belonging to the head, and the last being distributed over the whole surface of the body.

Each of these organs is admirably fitted for receiving the impressions peculiar to its nature, which, being made on its minute nervous filaments, are transmitted to the brain by means of the large nerve connected with it.

The impressions of form, colour, sound, odour, or touch, thus conveyed to the brain, are termed *sensations;* and if deeply impressed, so as to be retained in the memory, they are called *ideas.*

Perhaps the most important of all our organs of sense is that of *hearing*; as without that our race must have been mute, no language could have been formed, no knowledge propagated, nor could experience have ever been transmitted to benefit society.

The organ by which we become acquainted with every variety of sound is *the ear*, the air being the medium by which the vibrations or undulations of sound are conveyed to it; and without air sounds cannot be heard.

The ear is an organ of a very curious and complex structure; generally described as the external ear, the middle portion or drum, and the internal ear or labyrinth.

What is called the *external ear* consists of a cartilaginous kind of funnel for collecting the sound, and a short tube leading inwards for conveying it to the middle portion of the ear; some animals having the power of moving their ears to enable them the better to catch the sound.

The middle portion, called the *tympanum*, or drum of the ear, is a small cavity separated from the external ear by a thin membranous partition extended across it like a drum-head. Within this cavity are three[1] small bones attached to the drum and to each other, by means of minute ligaments, and provided with four small muscles for moving them. There are three openings leading from it into the internal chamber of the ear, and one connected with the back of the mouth, for the admission of air, called the *eustachian tube*.

The internal ear, or *labyrinth*, is a curiously constructed cavity, different parts of it being distinguished by different names; the central part called the vestibule, the back part the semi-circular canals, and the front part the cochlea; so called from its winding form like the shell of a snail. The labyrinth is lined with a pulpy membrane, in which are spread out the filaments of the auditory nerve; and also by a serous membrane, which secretes a watery fluid filling the different cavities.

All sounds are supposed to be conveyed to the brain in the following manner:—

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[1] The bones of the ear, called the *Malleus*, or hammer; the *Incus*, or anvil; and the *Stapes*, or stirrup.

The undulations of sound, striking the external ear, are by it collected and transmitted inwards to the membranous drum of the middle portion of the ear; the vibrations of which are taken up and conveyed, by the chain of bones and muscles, to the labyrinth; and from that by the nervous filaments and auditory nerve to the brain.

The next organ of sense, the most wonderful in its construction and extensive in its range, is that of the eye; conveying to the brain the radiant glory of the heavens and the myriad beauties of earth in a glance.

As the air is the medium of sound to the ear, so is light the medium of sight to the eye; which may be said to be an optical instrument of the most perfect description, taking cognizance of the forms, colours, and proportions of all objects within its ken.

The globe of the eye is a spherical body, about an inch in diameter, enclosed in three membranous coats, called the sclerotic, the choroid, and the retina; having also a circular transparent projection in front called the cornea.

The *sclerotic*, or outer coat, is a tough fibrous membrane, the front portion of which is covered over with a thin tendinous expansion of the muscles, forming what is called the white of the eye. The transparent projection in front, called the *cornea*, is set in a groove in the sclerotic coat, somewhat like a watch-glass in its case.

The *choroid* coat is an exceedingly vascular membrane, containing the chief arteries and veins for affording nutrition to the eye. Its exterior surface is of a deep brown colour, and its inner surface of a deep black, for absorbing the scattered rays of light. Connected with it in front is a thin membrane called the *iris*, which is extended across the eye immediately behind the cornea, like an inner curtain.

The iris has a small hole in its centre for the admission of light, called the *pupil* of the eye, and this hole can be contracted or expanded by means of the delicate muscular fibres of which the iris is formed. It is the iris that gives the eye its colour, being of different hues in different individuals.

The *retina*, or inner coat of the eye, is a delicate pulpy membrane, in which are expanded the filaments of the optic nerve, and by which the image, or visual impression, of every object is conveyed to the brain.

Within the three coats of the eye are contained three different kinds of transparent matter called *humours*, which by their peculiar nature, construction, and arrangement, transmit the impressions of objects to the retina. They are known as the aqueous, the crystalline, and vitreous humours of the eye.

The *aqueous*, or watery, humour is situated in front of the eye, filling up the space from the cornea to the crystalline lens; the iris floating in it.

The *crystalline* humour is a transparent, hard, jelly-like substance, in the form of a double convex lens, situated immediately behind the iris, and imbedded in the humour behind it.

The *vitreous* humour fills up the back, and by far the greater portion, of the eye. It is an extremely transparent substance, a little thicker than the white of an egg, enclosed in a film-like membrane.

The eye, thus constructed, perceives objects presented to it by means of a very minute picture of them being first formed upon the retina. The rays of light, passing from the object, are *refracted* by the cornea and aqueous humour, and *converge* towards a point in the crystalline lens of the

eye; where, crossing each other, they *diverge* to form a small reversed picture of the object upon the retina. This reversed picture, in its transmission to the brain, is supposed to be rectified by some mental experience, so that we see the object erect instead of reversed.

To add to the efficiency of the eye as an instrument of sight, the power of moving it in all directions is afforded by means of six small muscles; four[2] of them to move it upwards, downwards, inwards, and outwards, and two[3] others to roll round it in its socket.

To shield and protect so delicate a structure from injury, we find many wonderful contrivances provided. We find it set in a strong bony cavity, the interior of which is lined with a soft fatty substance on which it moves.

We see that the eye-brows above form a hairy embankment, to ward off the sweat of the brow. That the eyelids form a divided curtain, shutting with the rapidity of thought on approaching danger, while their lashes, by their fanning movements, prevent the intrusion of annoying particles. But, should dust chance to enter, the *lachrymal*[4] gland instantly sends down the flow of tears to wash out the impurity; the tears being the fluid which on other occasions keep the eye constantly bright and clear.

We perceive also the pupil instantly closed to exclude an excess of light, and to expand when more is needed. And finally at night, when rest is required for so active an organ,

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[2] The Rectus superior,
The Rectus inferior,
The Rectus internus,
The Rectus externus.

[3] The Obliquus superior, or Trochlearis, and—
The Obliquus inferior.

[4] A small gland in the upper portion of the orbit.

the eyelids close and shield it; and when shut lest, they should adhere too closely, we find minute glands,[5] in their edges, secreting a soft fluid, to oil and facilitate their opening in the morning.

The organ of the sensation of *smell* is the *nose*. The particles of all odorous bodies being carried, by the air, into its cavities fall upon their membraneous lining; in which the filaments of the olfactory nerves are expanded.

The external portion of the nose is formed of bone above and cartilage below, divided by a bony and cartilaginous partition into two equal compartments called the *nostrils*; the whole covered with the muscles, and enveloped in a thick integument.

The cavities of the nostrils extend backwards to the pharynx; their interior being divided from back to front into several passages, over which is spread out a thick spongy membrane, called the *pituitary* membrane. It is on the extended surface of this membrane that the nerves of smell are distributed, their minute filaments being kept moist by a fluid which it secretes.

The chief organ of *taste* is the tongue; on the surface of which are spread out the filaments of the *gustatory*, nerve, or nerve of taste, it being a branch of the fifth pair of nerves; two others also give it sensation and motion.

The tongue is composed of six muscles, the fibres of which are interlaced in various directions, and between which a portion of fat is deposited; four muscles direct its movements. It is abundantly provided with blood vessels, is enveloped in a tough mucous membrane, and is connected

[5] The Meibomian glands.

at the root to the *hyoides*; a small bone somewhat of the form of a horse shoe.

The sensation of *taste* is said to be produced in the following manner. The substance applied to the tongue, being moistened and partially dissolved by the saliva, is pressed against the sides and roof of the mouth, to bring it in closer contact, and to more readily excite the nervous papilla on the surface of the tongue. The filaments of the nerves, thus impressed, convey to the brain the peculiar taste of the substance tested; there are, however, some substances, taken into the mouth, that are partially tested by the sense of smell.

The sense of *touching*, or feeling, may be said to be common not only to all the organs described, but also to most parts of the body. Those parts, however, the most sensitive, and discriminating as organs of touch, are *the lips and extremities of the fingers*; the former taking cognizance of all substances entering the mouth, and the latter being in a great measure the especial organs of touch.

The nerves of sensation, distributed to the surface of the body, generally terminate in minute conical bodies called *nervous papillæ*, formed by little loop-like filaments of the nerves pushing up from beneath the outer membrane of the skin; each papillæ being also supplied with minute branches of the blood vessels.

Over the general surface of the body the papillæ are small, and irregularly disposed; but on the palms of the hands and extremities of the fingers they are large and prominent, arranged in parallel rows, forming the minute ridges seen on those parts.

The sense of touch is produced by contact with the thing felt, and is heightened by our attention towards it;

when the nervous papillæ, from being in a flaccid, state become excited, they extend themselves, as if to gather information of its qualities. The sense of touch is weakened by cold, or by any other cause which prevent the nervous papillæ from receiving the necessary supply of pure blood.

LESSON XV.

THE FUNCTIONS OF THE BRAIN AND NERVOUS SYSTEM.

THE BRAIN may be considered our great mental repository, in which is treasured up all our knowledge of the outward world and of our inward self; knowledge which our *senses* have from time to time conveyed to it, and which our *thoughts* elaborate and apply for good or evil purposes, according to the bent of our nature, and the instruction and training we have received.

The brain is also the chief director of those *movements* of the body necessary to give effect to its wishes; the nerves being the messengers which convey its will, and which stimulate each muscle to obey its mandates.

The brain, as already described, is divided into three great divisions called *lobes*, each having its peculiar and distinctive functions; the front lobe being the seat of the *intellectual faculties*, the middle lobe of the *moral sentiments*, and the back lobe and cerebellum the seat of the *animal propensities*. Different portions of those great divisions, being marked by distinctive peculiarities, are divided into a number of still smaller divisions called *organs*.

By the *intellectual faculties* are meant our powers of perceiving, comparing, judging, and reasoning; and by which we become acquainted with the laws of the universe, the facts and events of existence, and the experience of mankind.

By the *moral sentiments* are meant those powers which prompt us to sympathize and feel for others, to reverence

goodness and excellence, to love the truth and act justly, to fearlessly adhere to our conviction of right, and to labour with all earnestness to make mankind wiser, better, and happier than we find them.

By the *animal propensities* are meant those impulses which attach us to our offspring and our kind; which prompt us to indulge our appetites and gratify our passions, too often to the injury of ourselves and others; and which too frequently cause us delight in revenge, cruelty, destruction, and crime.

But the brain without the *senses* would be a blank, and, though crammed with all the knowledge of the past, would be useless without the nerves which execute its bidding. It is through these five inlets, the senses, that it gathers its information to store the recesses of the memory, upon which reflection dwells to form its bright thoughts and aspirations of good.

The beaming *eye* transmits to it a knowledge of the forms, proportions, and colours of nature's countless variety; and enables it silently to drink in the written knowledge of the present, and treasured experience found in the records of the past.

The *ear* imparts to it the rich tones of maternal affection, the gathered wisdom of the teacher, the wise admonitions and councils of friends.

The *hand* not only makes the brain cognizant of all the various qualities of touch, aids the eye in its discriminations of form and beauty, but can be trained to execute with precision, skill, and power, whatever its master dictates.

The *two other senses* are no less valuable contributors to the mental stock; standing as sentinels, to guard life's avenues, they afford warning of all noxious agencies that

may poison the blood and render the brain inactive; while their wise and proper gratification afford a large amount of mental enjoyment.

But, with all these wondrous instruments for conveying knowledge to the brain, it must chiefly depend on inclination, attention, and *mental effort*, whether the sensations conveyed shall become lasting ideas to store the memory, and to affords materials for thought and judgment, or be mere fleeting sensations leaving no lasting impression behind.

And *without knowledge*, to enable us to govern our passions, to expand and direct our moral nature, and to skillfully apply the productions of nature to the uses and comforts of ourselves and our brethren, we stand great risks of growing up in poverty, vice, and crime; unable to promote our own happiness, and retarding that of others.

A knowledge, however, of the threefold nature of the brain clearly shows us how much the formation of our own mind, and of our future character is in our own power. For as the muscles of the body are enlarged and strengthened by judicious *exercise*, so are the different portions of the brain; but the good or evil resulting from such increased power will altogether depend *on the part exercised.*

If we give way to the undue cravings of our appetites, and the impulses and sallies of our passions, they will become more and more powerful with every gratification; bad habits will spring up, and be strengthened by indulgence, and our better nature will become more and more the slave of our propensities.

But if we resolve to exercise our intellectual powers, to be industrious in acquiring useful knowledge, to obey the laws of our nature, and to cultivate our moral sentiments by

acts tending to human elevation, our mental energies will gradually acquire strength, and our moral nature a supremacy for good.

As the organs of sense, and the nerves of sensation connected with them, are the instruments for conveying information to the brain, so are *the nerves of motion,* proceeding from it, the instruments by which it carries its will into action; by which it stimulates the limbs to run its errand, the hands to execute its bidding, and the tongue to issue its commands.

These two kinds of nerves, leading to and from the brain, form the six columns of nerves composing the *spinal cord*; the front and side columns being the nerves of *motion,* and the back columns those of *sensation.* The nerves branching out of the spinal cord have also the same two-fold functions, as they spring both from motor and sensitive trunks; the filaments of the one generally distributed to the skin, and the filaments of the other to the muscles.

But if, by disease or accident, a division is made in the spinal cord, the brain has no longer any control over the lower portion; sensation is at once cut off, the power of *voluntary motion* is destroyed, and the parts or limbs supplied by it are immediately paralyzed.

Yet, so long as the nervous branches are attached to the spinal cord, there are various automic movements that may be induced; as for instance the limb can be made to move when the nerves on the surface are irritated. But of such movements *the brain is unconscious,* and over them it has no power; they being supposed to take place by the irritated nerves conveying the impression to the central matter of the spinal cord, and that, being of the nature of the grey substances of the brain, conveys its motive influence to the

muscles which move the limb; producing what are called *reflex* movements.

But although the brain is thus essential *for all power of thought and voluntary motion*, and though animals rise in the scale of intelligence in proportion as their brains approximate to those of human beings, yet it does not appear to be essential to *mere animal existence*; as there are many animals without brains, and many have lived for some time when accident or injury has deprived them of it.

The nerves of sensation and voluntary motion, or those belonging to our *animal life*, having been so far described, we have now to consider the functions of the sympathetic system, or those which belong to our *organic life*.

The *sympathetic, or organic nerves*, supplying the different organs within the body, their branches distributed over the blood-vessels, and their filaments supplying the minutest capillary, *are the nerves which stimulate the functions of these organs.*

Without their influence nutrition, respiration, circulation, secretion, and other organic functions could not be regularly effected; and were the nerves and ganglia which supply them to be cut off their functions would be at once impeded.

These important functions, on which animal life depends, are carried on by the agency of the organic nerves, from birth till death, without tiring, without rest; without the brain being conscious of their varied operations, and without any other feeling than that of the pleasurable existence which we call *health;* unless, indeed, some disease or disarrangement takes place, when the attention of the brain is at once directed, *by pain* or otherwise, to the remedying of the evil.

And this wise arrangement, calling the attention of the

mental powers to the fact that some of the laws of health have been broken, is, of all nature's numerous warnings, the most important and most wonderful; warning the brain that the stomach has been crammed, or under-fed—that the lungs are being injured by pressure, or weakened by the want of pure air—that the pores of the skin are obstructed by filth, or its delicate vessels chilled by cold—that the secretory and other organs are being over-worked in their endeavours to purify the system—and that the heart is fast losing its energy by some poisonous material in the current of the blood.

These warnings are conveyed to the brain by means of the nervous branches by which the sympathetic or *organic nerves* are united to the spinal cord and other sensitive nerves; the filaments of which, *commingling with those of the organic nerves in their course*, impart a feeling of joyous health only when all goes well, but when disease or danger threatens, swiftly sounding the alarum of *pain* to give the brain notice of the evil.

ADDITIONAL LESSONS

ON DIET, INTOXICATING DRINKS, TOBACCO, AND DISEASE.

LESSON XVI.

DIET.

By Diet is meant the various vegetable and animal substances used as food by different nations.

The necessity, or demand, for food is occasioned, in the *first* place for the growth and development of the bodily structure; *secondly*, for supplying it with new nutritious particles to replace those which are separated in the performance of its various functions; and *thirdly*, to afford material for keeping up the animal heat of the body.

Hence it must be evident that children, and young growing persons, require a larger supply of food, for the building up their bodily structure, then adults or full grown persons. That those who labour hard, and have abundant exercise, and waste of their bodily tissues, require more food than those who spend their time for the most part in indolence and inactivity. That a larger quantity is requisite for keeping up the heat of the body in winter than in summer, and in cold countries than in hot ones.

The different kinds of food that we consume, vegetable

and animal, may be classified under four heads; distinguished as the *saccharine*, or sugary—the *oleaginous*, or oily—the *albuminous*, or white of egg like—and the *gelatinous*, or glue like.

The two first classes of these substances from their not containing *azote* (or nitrogen) in their composition, are called *non azotised*[1] *substances*, and the two last, from their containing azote, are called *azotised*[2] *substances;* distinctions necessary to be observed, from the fact, that the latter, when taken as food, help to *build up the different tissues of the body*, while the former, by their combustion with oxygen, only serve *to keep up the animal heat of the system.*

In most kinds of food, in common use, these two classes of substances are found, though combined in very different proportions; one class being in its nature best adapted to afford nourishment to the different tissues, and the other, by its combustion within the body, to keep up its proper temperature.

Among vegetable productions, beans and peas contain about one part of nutriment to two parts of heat-producing matter; oatmeal about one of the former to five of the latter, wheat flour about one to eight, potatoes one to nine, rice one to ten, while sago and arrow root contain only one part of nutriment to twenty-six parts of heat-producing food.

Animal food however (including fish and flesh) contains by far the largest proportion of *azotised*, or tissue nourishing qualities; excepting the fatty and oily portions of them which belong to the *non azotised*, or heat-imparting class.

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[1] *Non azotised substances* are compounds of oxygen, hydrogen, and carbon.

[2] *Azotized substances* are compounds of oxygen, hydrogen, carbon, and nitrogen.

This knowledge, of the nature of food, teaches us that the highly nutritious and stimulating kinds are no ways compatible with a life of ease and inactivity, where there is little waste of the bodily tissues; and that the less nutritious, but heat-producing kinds, are better suited, in such circumstances, for imparting that heat to the body which active exercise would otherwise supply.

It also teaches us that a larger proportion of, what may be called, *combustion food* is required for keeping up the heat of the body in the winter season, when the external cold is constantly abstracting the heat from our bodies, than in the summer, when we are oppressed with heat. And it also teaches us, that warm clothing, in cold weather, will greatly supply the place of heat-producing food.

It should also teach fat and corpulent persons to avoid as much as possible saccharine, and oleaginous kinds of food; as not adding to the strength of their muscles, but merely serving to deposit a load of unhealthy fat in the minute cells and interstices of their bodies.

This same knowledge, of the nature of food, will enable us to determine what description of food is best suited to the human constitution in the varying circumstances of soil, climate, and country; as well as what is best suited, to the same individuals, under the varying changes of seasons, alternations of temperature, in-door or out-door employment, active exertion, or a sedentary life.

These *two great distinctive properties of food* having been described, it may be well to consider some particulars regarding different kinds of food.

Of *animal food*, in common use, *beef* and *mutton* are not only the most nutritious but the most digestible; *veal*

and *lamb*, and most young meat, being less so than the full grown animals; and *pork*, from its fat nature, being less nourishing than it is heat-sustaining.

The digestibility of meat also greatly depends on the cooking of it; for when it is *overdone* its fibre is hardened, and much of its nutriment wasted, and when *underdone* its dense texture renders it less digestible.

Fish, though less nourishing than meat, forms a most valuable article of diet when eaten fresh; but the *oleaginous* kinds, when salted, require strong stomachs to digest them. *Shell-fish* also, though exceedingly nutritious, is not easily digested.

Bread, which is justly regarded as the staff of life, should be made of good flour, care be taken that it be neither too fine nor too coarse; it should never be rendered sour by fermentation, should always be well baked, and should never be eaten new, nor when it has become mouldy; and these cautions equally apply whether it be made of wheat, barley, rye, oats, or a mixture of different kinds of flour.

Most kinds of *puddings*, *pastry*, and *rich cakes*, are rendered indigestible by the butter, fat and other ingredients combined in them; and should always be avoided by persons of weak digestion.

Fruits, when fully ripe, are cooling and nutritious, but should be sparingly taken after meals, as they are extremely liable to ferment the contents of the stomach; care should also be taken against swallowing the skins, stones, seeds and husks, as they are often productive of disease.

As regards *potatoes*, *carrots*, *turnips*, *peas*, *beans*, and most of our esculent roots and herbs, they are all, *when well cooked*, excellent additions to the dinner table, but hard

working people require the addition of some more substantial and nutritious kinds of food.

Different kinds of food having been considered, we have next to enquire the proper times for our meals, and the proper quantity of food to be taken.

As to the first question much must depend on the climate and habits of the people; in this country, however, the eight o'clock *breakfast*, the twelve or one o'clock *dinner*, the five or six o'clock *tea*, with some light refreshment at *supper*, have been found best suited to meet the wants of our working population.

And wherever fashion, or necessity, has set aside these meal-hours for late dinners and suppers, giving the stomach its heaviest labours to perform at the close of the day, restless nights and fits of indigestion have too frequently been the accompanying penalties.

Respecting the *proper quantity* of food to be taken, there is no truer guide than our *appetite*, if we have not weakened and destroyed its warning powers.

Whenever the body requires sustenance the demand is made known to the brain by the organic nerves of the stomach, producing the craving sensation called *hunger*; and creating what is called an *appetite* for food.

This natural appetite, when not perverted, is our surest guide respecting the quantity of food necessary for supplying the wants of the system; for if we eat it deliberately, and masticate it properly, causing it to be softened by the saliva and gradually mixed with the gastric juice, our appetite will remind us when enough has been taken.

But it frequently happens that this healthy appetite is gradually perverted and diseased, by stimulants and repeated excesses, until its true exciting influence is lost, or a morbid

and unnatural feeling created; inducing a desire for food beyond the power of the stomach to digest it, or the requirements of the body if it could.

The undue quantity of food thus consumed, through a vitiated and depraved appetite, *and not required for the wants of the system*, not only tends still further to weaken the stomach, but to disorder other organs by their efforts to get rid of the superfluity.

Injury to health is also done by taking our meals immediately after violent exercise, as well as by resuming our labours the moment we have done eating; a short rest being requisite, so as to allow the excess of blood to return from the extremities, the stomach requiring a large supply of it for the purposes of digestion.

Respecting *drink* it may be necessary to state, that copious draughts of cold liquids are injurious to the stomach during meals, or immediately after them; as they weaken its digestive powers by lowering its necessary temperature, as well as render its contents too diluted for easy digestion. With some kinds of food no liquid is required, and the small quantity needed for moistening very dry food should be slowly taken, and this warmed a little by the mouth before it is swallowed.

Tea and coffee, forming so large a portion of the diet of our population, are beverages not only cheering and refreshing in all the circumstances of cold, heat, thirst, and fatigue; but are in their chemical nature highly beneficial to health. Their *azotized* principles are said to be superior to those of any other vegetable compounds in promoting the healthful secretion of bile, and by that means the purification of the blood; to which may be attributed their salubrious influence on the system.

Of these drinks, however, we ought to be careful not to take too large a quantity, as tending to overtax the secretory organs; nor swallow them too hot, as tending to weaken the mucous lining of the stomach. Of the kinds of teas, *black* is to be preferred; the *green*, being highly stimulating to the nerves, should be avoided as a common drink.

Cocoa also forms a very nutritive and refreshing drink, and, from its oily nature, is to be preferred for keeping up the heat of the system in cold weather.

Milk is not only excellent as drink, but is also highly nutritious as food; its curd being of a nature to afford nourishment to the tissues of the body, while its cream, or buttery particles afford heat-producing food. Milk, thus combining the two essentials of food, and easily digested by the healthy stomach, is excellent for children; and in the first nine months of their existence little more is required by them. Those persons, however, who have weak stomachs cannot well digest it.

Of the comparative digestibility of various kinds of food, much must depend on age, constitution, and state of health: for the same person, in some circumstances, will take twice the time to digest the same kind of food as in others.

The following estimate, however, of the time required for digesting different kinds of food, is taken from experiments made on an adult person in good health.[3]

Rice, tripe, sago, and milk, take from *one to two* hours to digest—mutton, beef, pork, lamb, bread, potatoes, soft-boiled eggs, chicken, cod-fish, and oysters, from *two to three* hours—and cheese, carrots, turnips, salt-beef, veal, sausages, ducks, and fowls, from *three to four* hours.

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[3] On Alexis, by Dr. Beaumont, of Canada.

As attention to *diet* is one of the best means of preserving health, as well as for regaining it when lost, it should be generally known that more evils result from taking too much food than from taking too little—that taking a great variety of food into the stomach at one time renders the whole less digestible—that we are more subject to atmospheric influence and disease when the stomach is empty than when it is supplied with food—that long fasting is injurious, and especially to young persons—and that a moderate portion of plain food, careful exercise in the open air, and an easy contented mind, are remedies for a weak stomach and diminished strength, superior to all the tonics, pills, and purgatives in the universe.

LESSON XVII.

INTOXICATING DRINKS.

The intoxicating principle in all liquors is ALCOHOL; a limpid colourless fluid, of a strong pungent nature, obtained from various substances by the processes of fermentation and distillation.

By *fermentation* is meant the peculiar change which all vegetable matter undergoes in a state of decay; which in the making of wines, cider, perry, and other *fruit* liquors, spontaneously takes place, and being *checked at a particular point* forms the liquor;—but in the making of beer, ale, porter, and other *grain* liquors, the fermentation is artificially produced by the process of brewing.

By distillation is meant the separation of the alcohol contained in fermented vegetable substances, by the agency of heat; with the aid of an apparatus for collecting the alcoholized vapour which arises from them in the process of boiling.

The quantity of alcohol in different liquors varies considerably; brandy, rum, gin, and whisky containing about *fifty per cent of it;* strong wines of different kinds from *eighteen to twenty-two;* and ale, beer, porter, and cider from *six to ten per cent.* The colour of most of these drinks, and much of their flavour and intoxicating quality, would seem to be artificially produced by those who deal in them.

By some medical men alcohol is classified as a *poison,*

and is proved to be so by its effects on animal life; a small portion of it being sufficient to kill a dog, almost instantaneously; and no very large portion of it taken into the human stomach has often proved fatal.

When alcohol is taken into the stomach it is rapidly absorbed by the gastric vessels, and, passing into the circulation of the blood, is instantly conveyed to the brain; an organ which it irritates and excites in an especial manner, from the great affinity which it has for nervous matter.

When a moderate quantity of it is drank, the first sensation is that of warmth in the stomach, accompanied with an increased circulation of the blood, and an excited action of the brain; producing a wild and incoherent fancy, a flow of thought, often without order, and too frequently stimulating the passions beyond the control of the superior faculties.

This excited state (the power of mental control being *weakened)* stimulates drinkers to exhibit, without reserve, their prominent propensities; causing some to be quarrelsome and pugnacious, some to be ridiculously vain, some to talk sillily and act stupidly, some to sing boisterously, and others to be devoutly melancholy and sad.

These *first effects* are said to be produced by the poisonous nature of the alcohol unnaturally stimulating the blood-vessels, disordering the blood, irritating the brain, and giving a forced energy to the muscles; effects similar to those which are produced by many other kinds of poison when first taken into the system.

When, however, an additional quantity of intoxicating drink is taken a reaction takes place; the blood-vessels become weakened and distended, the circulation somewhat impeded, the respiration slower, the heart and lungs oppressed, the mental powers obscured and wandering, the sight clouded,

the muscles relaxed, the power of voluntary motion weakened, and the whole system thus affected by the noxious poison causes the body to reel to and fro in drunken helplessness.

In this state of prostration the drinker may be said to have *lost* all proper self-control, the brain being either irritated into madness, or drowned in stupor; if the former, the symptoms are perceived in his distorted features, dilated eye, irascible temper, and tongue thickly uttering its imprecations of rage and madness;—and if the latter, his bewildered head, stupid brow, and utter helplessness of body, cause him to sink to rest in a lethargic, and too often in an apoplectic sleep.

These last being the effects of the poison, *when diffused throughout the system*, it may be well to trace the manner in which it is supposed to operate on the different organs of the body, so as to produce such intoxicating results.

The alcohol taken, being rapidly absorbed by the vessels of the stomach, acts immediately upon the blood, diminishing its red globules, and causing its fibrine to be less coagulable; by which means the blood becomes darker and thinner, and less fit for nourishing the body.

But alcohol not only injures the general quality of the blood in this way, but, being diffused throughout the body, it also *robs the arterial blood of its oxygen* in its course from the lungs. This it does by its carbon having so great an affinity for oxygen that it penetrates the coats of the arteries to combine with it; by which means the whole mass of blood gradually becomes more and more of *a venous quality*, and less and less capable of affording nutriment to the different tissues of the body.

The blood, being thus altered in its properties, will not so readily penetrate the minute vessels of the body, by

which means the large vessels become overgorged, and the general circulation impeded.

The lungs, the especial organs for removing carbonaceous matter from the blood, and for supplying it with oxygen, have their respiratory power also diminished by the paralyzing effect of the alcohol on the nerves of respiration; at the very time too when their increased action is rather required to free the blood from its extra impurities.

The brain and nervous system also, instead of being healthfully stimulated by good blood, are irritated, inflamed, and hardened by the alcoholized poisoned blood, and their natural functions consequently impaired.

The muscular fibre likewise, not having its supply of nutritious blood, becomes flaccid and feeble; and the nerves of motion, no longer under the control of the will, cause the whole muscles of the body to give way, and contract spasmodically, as the staggering drunkard reels on in his course.

Such being the immediate effects of intoxicating drink, it may readily be supposed that this general derangement of the whole system cannot often take place without disease being induced. It may be useful, therefore, to trace its morbid effects on different organs, and the *diseases* which persons indulging in the use of those drinks are particularly subject to.

The effects of alcohol on the *stomach* is first to irritate its mucous lining, and over-excite its nerves and secretory vessels, so as to create a morbid appetite for food *beyond the wants of the system;* causing the bloated and inflamed appearance we see in many persons. If the stimulant is continued, inflammatory patches and ulcerous spots break out in the interior of the stomach, accompanied by a vitiated

state of the gastric juice, and a diminished appetite and power of digestion. If the habit is persevered in this is followed by a still more diseased state of the stomach; such as inflammation, dyspeptic spasms, morning vomiting, spitting of blood, and ulcerated states of its interior.

The *bowels* are not only affected by this inflamed and diseased state of the stomach, but they are otherwise injured;—first by the alcohol weakening the fibres of the pylorus it permits the *undigested* food to pass out and irritate them;—secondly by its coagulating and fermenting the food in the stomach it also tends to disorder them;—thirdly by its rendering the bile less alkaline it ceases to be a proper stimulant for promoting the healthy action of the bowels, which leads to a costive habit of body, and that state too frequently to other diseases. It also often brings on (more especially in females) such an irritable state of the intestines, as to prodnce an almost constant state of diarrhœa.

Diseases of the *liver* are common and notorious among those who indulge in the use of intoxicating drinks; and more especially among those of sedentary habits, or who work in doors. The alcholised blood, being almost immediately conveyed to the liver, tends to inflammatory disease, in consequence of the excess of carbon to be removed, as well as from the acrid nature of the alcohol.

The liver thus constantly overgorged with venous blood, and inflamed by over exertion, becomes at last soft and flaccid in its texture, and weak and torpid in its functions. The disease sometimes causing it to expand to double its size, with a fatty degenerate kind of matter deposited between its lobes, and at other times causing it to waste away considerably below its usual dimensions.

A peculiar disease of this organ, in which it becomes

granulous, or full of small brown tubercles, while its surface is covered with small hard prominences, is called, the "hobnail'd, or gin-drinkers liver;" from its being so common among drunkards.

In hot weather, and in hot countries, all these diseases are aggravated; by reason of the atmosphere being so rarified that the same volume of air does not contain the same quantity of oxygen to burn off the excess of carbon which intoxicating drink occasions.

The *kidneys*, being like the liver depurating organs, are subject to similar inflammatory and degenerating diseases, from the use of intoxicating drinks; such as enlargment and change of structure, granular deposit, and general derangement. From their impaired functions, as well as from mineral and acid substances combined in different drinks, serious diseases of another description arise, such as gravelly deposits and stony concretions in the bladder; diseases exceedingly dangerous, and accompanied with pain of the most intense nature. These last diseases are common among wine and porter drinkers.

Diseases of the *lungs*, both acute and chronic, are also prevalent among those who indulge in intoxicating drinks. Consumptive disease is induced by a vitiated state and obstructed circulation of the blood; such as is produced by strong drinks. An inflammatory state of the lungs is frequently occasioned by the acrid nature of the blood, and the fumes of the drink, irritating the delicate lining of the air vesicles and bronchial tubes; rendering the whole organs highly susceptable of changes of temperature, and consequent disease. And nervous affection, and diminished action of the lungs, are produced by the pernicious effect of alcohol on the nerves of respiration.

The *heart and blood-vessels* are also liable to disease from the use of those drinks. The irregular circulation caused by the alcohol, and its effect on their interior producing frequent inflammation, tends to weaken the elasticity of the arteries, and to ossify the valves of the heart; giving rise to palpitations, aneurysms, and other maladies.

The *secretory glands, nerves, and vessels of the skin,* have their functions also impaired by alcohol, which prevents noxious matter from escaping, and renders the skin more susceptable of cold; thus producing erruptive and cutaneous disorders, the evidences of which are frequently seen in the blotched face and pimpled red nose of the sot.

The *brain,* however, the most important of all the organs of the body, is most seriously affected by intoxicating drink; its indulgence not only tending to undermine the strongest constitutions, but to destroy, mentally and morally, the most highly gifted of mankind.

The immediate effect of alcohol on the brain is to excite the passions into activity, and weaken the power of self-control; while every subsequent indulgence gives the morbid craving for drink a gradual ascendancy till it has acqnired a *mastery,* and too often prostrated the nobler powers of the man below the level of the brute.

Alcohol being conveyed to the brain, in the current of the blood, the character of which it alters by its poisonous nature, causes the serous, or watery, portion to penetrate the sides of the vessels into the surrounding tissues. This, combined with alcohol, operating on the delicate membranes, vessels, and medullary matter of the brain, irritates, hardens, and injures them; and eventually destroys their functions. Moreover, as every operation of the brain is accompanied by waste, it needs *pure* blood to nourish and

repair it, instead of the poisonous fluid described; which pure blood not being afforded the brain consequently suffers. Hence by these joints effects the brain is gradually impaired; and imbecility, insanity, delirum tremens, and other mental diseases induced. Upwards of one seventh of the *lunatics* in the asylums of the United Kingdom alone are proved to be the victims of intoxicating drink; and, from a recent American report on *idiocy*, one-half of these unfortunate beings have been proved to be the children of drunken parents.

Seeing then that the use of intoxicating drink tends to inflame, corrupt, and disease the whole bodily structure—that every *moderate* indulgence of it serves to create a morbid appetite in its favour, and *step by step to weaken the power of self-control*—that the strong and the weak have equally become its victims—that it forms the prolific source of most of the diseases that afflict us—that half of the crimes committed can be traced to the love of drink—that it dries up, or poisons the fount of education—that it saps the mental and moral stamina of our people, and forms the great barrier to all social and political progress—perceiving all this are we not *morally* bound, *not only to avoid the temptation ourselves*, but by *precept and example* to dissuade others against so insiduous an enemy.

But we are told, by the interested and the unreflecting, that drink will the better help us to perform labour, sustain fatigue, endure cold, and help us to withstand the world's hardships and man's oppression! assertions having no foundation in fact, and disproved by abundant evidence.

That it cannot give us strength to labour is proved by the fact, that alcohol not only does not contain any element

that can be converted into blood, but that it always injures the blood's nutritious properties.

That so far from helping us to endure fatigue, the poisonous effect of alcohol in the blood prevents the nourishment of the muscle; while its stimulating effect on the brain leaves the body in a state of greater depression.

That instead of drink keeping out cold it lowers respiration, and consequently prevents the usual supply of oxygen, the great essential for keeping up animal heat; thus it rather diminishes the power of resisting cold, and is for that reason frequently eschewed in frozen regions.

That a sound mind, a healthy constitution, a comfortable home, and an earnest resolution to perform our mission bravely, are the essentials for enabling us to withstand the hardships, difficulties, and oppressions we may meet with in our journey through life; poor and paltry substitutes for which can be found in intoxicating drink, and in the cheerless misery of a drunkard's home.

LESSON XVIII.

TOBACCO.

Tobacco is manufactured from the leaves of a plant which is a native of America. The plant, in favourable soils, attains the height of from three to six feet, its leaves varying in length from ten to twenty inches. *Snuff* is formed of the leaves ground to a powder, often mixed and adulterated with other ingredients.

Tobacco is classified as one of the strongest of our vegetable poisons; a few drops of its essential oil, being taken into the stomach, produce violent convulsions, often terminating in death.

The use of this pernicious plant is said to have been unknown to our hardy forefathers; the filthy habit of smoking having been copied from the savages of America, and introduced into this country about 290 years ago. The habits of chewing and snuffing (still lower degrees of a disgusting indulgence), soon followed its introduction.

The habit of indulging in this "fashionable poison," in different forms, being so prevalent in this and other countries, renders it necessary that all should be made acquainted with its baneful effects on the system; not only as a caution to the young against the formation of such habit, but, if possible, to enlist the sympathies of the old, and to call forth their warnings agains it.

The first indulgence in tobacco smoking generally produces nausea and disgust, the organic nerves exciting the

system to eject the noxious particles which find their way into it; and though these symptoms are mostly got over by subsequent indulgence, it is only done by the weakening and blunting of those nerves which were given us to stimulate the stomach, and to warn the brain of noxious agencies.

Tobacco smoking produces dyspepsia, or indigestion; and this in various ways.

In the first placed the *saliva*, so necessary for digestion, is always injured by the acridity of the tobacco, and often wasted by the smoker; thus weakening digestion in two way; by the adulteration of the saliva, and by its scanty supply.

In the next place a portion of the tobacco cannot be prevented from entering the stomach; and this, by its sedative noxious qualities, paralysing the nerves, prevents the secretion of healthy *gastric juice* to dissolve the food. It is supposed that by its operation in this way tobacco weakens the appetite, as well as checks the feelings of hunger, for which purpose it is often taken by the Indians of America. It also occasions indigestion by weakening the muscular energy of the stomach.

Tobacco smoking not only thus prevents good blood from being formed by digestion, but also vitiates whatever blood is formed; as it is absorbed into the system in many ways.

In the first place its poisonous oil, oozing through a filthy pipe, and coming in contact with a raw place, is directly absorbed by the blood-vessels of the lips, and has been known to produce fatal effects.

Its pernicious smoke, inhaled and absorbed by the lungs, readily conveys its noxious properties throughout the body; and so powerfully does it thus operate on weakly constitutions as to frequently occasion syncope, or fainting.

Tobacco, by its *narcotic* nature, also stupifies and

weakens the whole nervous system; which being depressed, the necessary amount of carbonic acid is not expired, and the carbon and other impurities being thus retained, the blood is rendered less nutritious and stimulating; thus occasioning feebleness of mind and body.

These causes are in themselves sufficient to account for the pallid cheeks, declining health, and consumptive affections of both young and old who indulge in the use of tobacco smoking; as well as for the indigestion, mental lassitude, palpitations, vertigo, nervousness, and endless diseases of the nervous system, which have been so prevalent since the introduction and use of this poisonous weed.

Smoking also renders the breath intolerably offensive, discolours and decays the teeth, and, by weakening the gums, causes them to loosen and drop out.

The *chewing of tobacco* is equally injurious to health, and perhaps more disgusting to the sight than is the habit of smoking. It has also been known to produce cancerous tumours in the mouth.

It may be urged in objection to these statements, founded on medical testimony, that numbers of persons are to be found enjoying robust health notwithstanding their indulgence in these habits. But the same might be said of those who seem to enjoy health, for a season, in violation of all its laws; drinking, eating, and indulging in excesses of every kind. But it would seem that these appearances are generally fallacious; as all statistics go to prove, that those persons live longest, and happiest, who avoid all hurtful habits, *and obey the laws of healthful existence.*

It should also be remembered that the practice of tobacco moking is not only in itself injurious, but that it too often eads to drinking habits; as its use excites a demand for

drink, and its strong acrid nature renders the use of water and other healthful beverages insipid and unpalatable to the smoker's taste.

The habit of *snuff taking* is no less injurious to the health of those who indulge in it than are the habits described; and, from the frequent snuffing, the constant blowing, the begrimed face, the besmeared clothes, and the floating particles wafted in all directions, is perhaps still more loathsome and offensive to others.

As the particles of snuff find their way into the back of the mouth, by the passage of the nostrils, their pernicious effect on the stomach, and other internal organs, are similar to those produced by the habits of smoking and chewing.

Snuff also, by its poisonous and acrimonious qualities, corrodes the lining membrane of the nose, and thus occasions that snuffling inarticulate pronunciation we so frequently witness among inveterate snuff takers. And by its impairing the minute filaments of the olfactory nerves, which are spread out over the pituitary membrane, the sense of smell is often blunted, and frequently destroyed.

The eyes of snuff-takers are likewise affected in many ways by this vicious habit, and blindness often ensues. Their sense of vision is often impaired, by the constant drain of the fluids which snuff occasions; its pungent properties unnaturally exciting the secretions, produce the same decaying effect on the humours of the eye as is seen in the eyes of aged persons.

The floating particles of snuff have also *a direct* tendency to inflame the eyes, often leading to the loss of sight; for persons employed in the manufacture of snuff are particularly subject to *inflammation* of the eyes, lungs and digestive organs.

Snuff takers are also subject to frequent inflammations of the head and eyes from colds; the hot acrid nature of the tobacco causing the pores of the skin to be unduly extended, in order to pass off its noxious properties, render them extremely susceptible of colds.

The constant secretion and drain of the fluids, which snuff-taking occasions, also cause the cheeks to become prematurely furrowed, and the skin and muscles of the eyes wrinkled; while the absorbed particles embrown the nose, render the face sallow, and disfigure the whole features.

But the use of this irritating and poisonous powder is not only thus injurious to the health of those who take it, and highly offensive to those who come in contact with them, but calls, in an especial manner, for the reprobation of the public against it.

For, when we consider that the habit of snuff-taking is indulged in by thousands who are employed in the manufacture of our daily bread, and various articles of diet, as well as by vast numbers who cook and prepare our food, when we reflect on the poisonous and disgusting particles that must often be blended with what we consume, it excites our loathing against the abominable practice.

In thus stating some of the evils attendant on these filthy habits, it may be necessary to impress upon the minds of the unreflecting, who, in public and private, thoughtlessly dose their noses with snuff, and puff their pipes and cigars to the injury of their own healths, and to contaminate the air which other people are compelled to breathe, that the sum spent upon tobacco and snuff, in this country alone, amounts to upwards of *seven millions and a half annually*—a sum which, if wisely applied, would enlighten and bless thousands of their brethren, and save thousands from pauperism and crime.

But we often hear the medicinal virtues of tobacco urged in its favour, and, from the popular belief in its efficacy for divers complaints, numerous evils have resulted; especially from its application as lotions, fomentations, and otherwise, by ignorant and unskilful persons.

Formerly many virtues were ascribed to tobacco which the light of modern science has proved to be fallacious; and though it may now be found to be medicinally useful in rare cases, and in peculiar circumstances, yet, from its poisonous and dangerous nature, it should only be applied under the advice of medical practitioners.

LESSON XIX.

DISEASE.

By Disease is meant some alteration in the structure or functions of living bodies, occasioning their usual action to be performed with pain or difficulty.

Diseases are said to be *local* when they are confined to any particular part of the body—and *general* when the whole system is affected. They are called *acute* diseases when they come on suddenly and terminate quickly, and *chronic* when they are the reverse of this. They are termed *hereditary* when they are transmitted from parent to child; *epidemic* when they affect any large number of persons; and *contagious* when they are of a nature to be communicated to others.

Diseases may spring from various causes; the most common arising from sudden changes of temperature, impure air, a poor and insufficient diet, unwholesome food, overfeeding, the use of intoxicating drinks, the want of proper exercise, mental and bodily over-exertion, noxious agents taken into the body, or from blows or injuries inflicted on it from without.

Sudden alternations in the temperature of the body produce a great number of, what are called, *inflammatory diseases;* the parts, or organs, inflamed generally becoming red, swelled, hot, and painful; and their usual functions greatly impeded.

This diseased state is supposed to be effected by the change of temperature contracting the size of the capillary

vessels; causing, at first, the blood to be propelled through them with force and difficulty, and occasioning the serous, or watery, portion of it to force its way through the sides of the vessels into the surrounding tissues.

The vessels becoming weakened by this increased action, and the character of the blood altered by being deprived of some of its essential properties, it will no longer penetrate the minute vessels; its circulation will be thus gradually impeded, and finally it will congest and stagnate in the vessels.

But it frequently happens, that if one part of the body is exposed to damp, draught, or chilling cold, another part will become inflamed or diseased; and this by reason of the increased activity arising from the extra amount of duty imposed on such part.

As for instance, if the perspiratory vessels and glands on the surface of the body are chilled, so as to prevent them from secreting and passing off the usual quantity of noxious matter, the kidneys, bowels, lungs, and liver are likely to be inflamed through their extra activity occasioned by their endeavours to remove it.

In like manner, wet feet, damp clothes, exposed chest, bare legs, and insufficient clothing in cold weather, by throwing a disproportionate quantity of blood inwards, tend to bring on internal inflammations and diseases; the evil being increased by a weakly organization and a low state of health,

Impure air is productive of some of the most fatal and severe diseases that can afflict humanity.

The terrible scourges of plague, pestilence, and malignant fevers, that we so frequently hear of in other countries (and which were once prevalent in our own) are supposed to be occasioned by a *vitiated atmosphere;* arising from noxious undrained swamps, decaying vegetable and animal sub-

stances, and the open, stagnant, putrid drainage, and filthy habits of crowded populations; scourges which improvements in cultivation, draining, and cleanliness can alone banish from the world.

Most of the epidemics of fevers, agues, cholera, and dysentery, that still afflict us, are to be traced to the same deteriorating cause, an *impure atmosphere;* ague being still prevalent in damp marshy districts, and typhus, cholera, and other diseases are constant visitors in the undrained, filthy, and crowded courts of our large cities.

But numerous as are the annual victims of these dreadful diseases, they are comparatively few to the vast numbers who are annually sacrificed by various diseases generated by the *impure air* of their shops and factories; and the deteriorated atmosphere and imperfect ventilation of their own dwellings.

Though it is not so much from the noxious particles, fumes, and exhalations that arise from many of the substances used in our manufactures that disease is generated, as it is from the want of a free ventilation in our workshops, to dissipate them; and from the absence of care and cleanliness in the work-people themselves.

For, apart from these noxious influences, the condensed and vitiated effluvia from their own lungs is in itself the deadliest of poisons; and if there is not always a constant supply of fresh air to purify their blood as it is sent to the lungs, the poison must remain in the system, to the gradual injury of their healths, or the speedy destruction of their lives.

A poor and insufficient diet is also the cause of a great number of scrofulous, consumptive, nervous, and other diseases.

In children, and young growing people especially, if they

have not a sufficient quantity of nutritious food, their full development will be checked, their bodily and mental powers enfeebled, and a weak, scrofulous constitution will be frequently generated.

If hard-working people are deprived of proper sustenance, for keeping up the constant waste occasioned by their active exertions, their health and strength will gradually give way; and their brains, wanting the necessary stimulus of nourishing blood, will be weakened, and produce a derangement of their mental powers.

With constitutions thus injured and depressed, they will frequently lose their powers of self-control, they will become incapacitated for active bodily and mental exertion, and they and their debilitated offspring will generally be the first victims of epidemic disease.

Unwholesome food, such as diseased and tainted meat, adulterated and moulded bread, rotten cheese, stale fish, unripe and decaying fruit, stale vegetables, and rancid pork and butter, frequently occasion diseases in the stomach, bowels, and other organs; and more especially in persons of weakly constitutions.

These substances, taken into the stomach, derange the digestive organs, prevent the formation of good blood, and inflame the bowels by their efforts to get rid of the poison; and, should their impure particles enter into the circulation, they injure the properties of the blood, and occasion many terrible diseases. It is by unwholesome food deranging the whole bodily system, that scurvy, gangrene, and other eruptive diseases are engendered.

Over-feeding is also the cause of a far greater number of diseases than is generally supposed.

The rational object of taking food being to supply the

natural wants of the body, if more is taken than is requisite for that purpose, the superfluous portion tends to promote disease; either over-burthening the body with unhealthy fat, and highly inflammatory blood, or weakening various organs by their endeavours to remove the superfluity and purify the system; thus engendering a long train of dyspeptic, bilious, nervous, and other diseases.

Mothers often generate disease in the milk necessary for their offspring by taking over-stimulating and improper food; and as their children grow up, they too frequently ruin their constitutions by over-feeding and indulging them. For, if the appetite is constantly pampered by dainties and excess, the stomach will become depraved and vitiated, craving more than nature requires or reason dictates, and, sooner or later, will have to pay the penalties of disease for its excesses.

The use of intoxicating drinks is not only the cause of a multitude of mental and physical diseases, but is also the chief cause of most of the moral evils of this country; the largest proportion of crime and pauperism having been clearly traced to that source. Among the class of diseases it occasions are those of insanity, idiocy, delirium, epilepsy, paralysis, gout, rheumatism, inflammation of the brain, as well as diseases of the stomach, liver, kidneys, lungs, skin, and other organs of the body.

The want of proper exercise is also productive of disease; occasioning imperfect nutrition, weakness and deformity of body, and feebleness and lassitude of mind.

Proper exercise, by bringing the different muscles into action, force the blood with greater rapidity through the vessels; the veins conveying a greater quantity of waste and carbonaceous matter back to the lungs, and the arteries, bringing from the heart a larger stream of pure arterial

blood, to stimulate and nourish the various tissues, and keep up the animal heat of the body, impart energy and vigour to the whole system.

The want of such exercise occasions a sluggish circulation, a low temperature of the body, impurity of the blood, a constipated habit, varicose veins, swelled legs and feet, and frequently a scrofulous and gouty constitution.

The muscular tissue being also weakened, for the want of exercise, leads to spinal and other deformities; the muscles losing their power to sustain the weight imposed on them.

In like manner as proper mental exercise gives the brain increased energy and power, so does mental inactivity prevent its full development, enfeeble its powers, and disorder its functions; often producing melancholy, or hypochondrism, and mental imbecility.

But, necessary and beneficial as exercise is to the system, *mental and bodily over-exertion* are to be guarded against as highly debilitating and injurious.

When the muscles are *over-exercised* they become irritated and inflamed, and the nerves sympathizing with them produce a general lassitude of the whole body. And if this over-exertion is continuous from day to day, and the powers of the system are such as not to supply the waste occasioned, rheumatic pains will soon be felt, a feebleness of body generated, and premature old age be induced.

Over mental exertion not only deprives the skin, stomach, and other organs of their necessary nervous stimulus, and thus weakens them, but, by keeping the blood-vessels of the head constantly over-distended, it produces nervous irritability and mental derangement.

Noxious substances taken into the body, whether by the

lungs, stomach, or skin, produce their prejudicial effects on the system according to their nature.

Poisonous effluvia and noxious gases, absorbed by the lungs, are almost instantly commingled with the blood; hence the sudden effect so frequently produced on persons breathing them; and hence also the agues and fevers occasioned by persons breathing putrid vegetable and animal exhalations.

Noxious matters taken into the stomach are varied in their effects; some are immediately expelled by its reverse action, others violently stimulate and inflame the whole course of the stomach and intestines, while others are absorbed into the system, and disease and stagnate the whole mass of blood.

Putrid substances, absorbed through a slight wound in the skin, have been known to deprive animals of life in a few hours; and from a similar cause many medical men have lost their lives in dissection.

The infliction of blows and injuries on the body is often the cause of disease, and not unfrequently of sudden death.

Blows on the face have often led to the loss of the nose, and to the deprivation of sight. When inflicted on the skull, have frequently produced apoplexy, have often injured the mental powers, and at times caused raving madness. Sudden blows on the pit of the stomach have often proved fatal; when inflicted on the breast, have often occasioned cancerous tumours, while blows on the abdomen have often produced ruptures of the stomach and bowels.

But of all sources of disease from external injury, none have been productive of greater evils than those occasioned by the compression of the lungs, and the other viscera, by means of stays and bandages round the body. For by

such pressure the free expansion of the lungs is prevented, the body distorted, the blood vitiated, consumption and other diseases generated, and the maladies occasioned by the practice are too often transmitted from one generation to another.

In addition to the causes of disease enumerated might be included the want of cleanliness, together with many other bad habits and practices generated by ignorance, indolence, and vice.

But, happilly for us, all these diseases which afflict humanity, and which ignorance and credulity formerly ascribed to malignant powers and supernatural agency, have been mostly traced by enlightened and scientific men to their true source—*to the neglect or infringement of some of the great physical and moral laws of the universe.*

These affording daily warnings to men, collectively and individually, that disease can only be avoided, and health and happiness secured, by every man endeavouring to live in accordance with those eternal laws; and by his making every possible exertion to cause others to understand and obey them.

And, in concluding this lesson, let it be engraven on our memories, *that the exercise of our own moderate abilities to prevent disease,* is far better *than the exalted wisdom of others to cure it.*

But, with all our caution, should disease unhappily come upon us, let us avoid all kinds of tinkering nostrums; and remember that the most skilful physician will then be found our best, our safest, and cheapest guide.

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